ALBERTA ENVIRONMENT SUMMARY REPORT ON 2004 NPRI AIR EMISSIONS

Alberta
ENVIRONMENT

Disclaimer:

The source of the industrial emissions data used in this report is the April 25, 2006 version of the 2004 National Pollutant Release Inventory. This data was compiled by Environment Canada, not Alberta Environment, and Alberta Environment therefore cannot guarantee the correctness of the data. Decisions based on our analysis are solely at the discretion of the user.

The NPRI emissions data is restricted to emissions from industrial sources that exceeded set reporting thresholds for the groups of substances. The following analysis is restricted to on-site air releases and may differ in the number of facilities reporting to the NPRI, as any facilities that reported blank or zero air emissions for a substance, have been excluded for that substance.

Prepared by:

Evaluation and Reporting Section
Environmental Monitoring and Evaluation Branch
Environmental Assurance
Alberta Environment
12th floor, Oxbridge Place
9820 - 106th Street
Edmonton, AB
T5K 2J6
Phone: (780) 427-0685
Fax: (780) 422-8606

Additional copies of this document may be obtained by contacting:

Alberta Environment Information Centre
Main Floor, 9820 - 106 Street
Edmonton, Alberta T5K 2L6
Phone: (780) 427-2700 (Toll free by first dialing 310-000)
Fax: (780) 422-4086
E-mail: env.infocent@gov.ab.ca

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Executive Summary

One of the first steps in addressing air issues is to get an accounting of what is put into the air by various sources. This accounting is what is known as an emissions inventory. An emissions inventory is needed in order to be able to manage air emissions. Alberta Environment requires that many industries collect and report air emissions data and limit their emissions as part of the approval process under the *Environmental Protection and Enhancement Act* (EPEA). Environment Canada compiles the National Pollutant Release Inventory (NPRI), which is an inventory of industrial emissions across Canada from facilities that meet set reporting criteria. The emissions data collected under EPEA approvals is supplemented by NPRI data to help meet Alberta's emissions inventory needs.

Industrial facilities are just one source of air emissions. Other sources include transportation, home heating, agriculture, forest fires and many others. Emissions reported under EPEA approvals and to the NPRI are restricted to what is considered industrial sources. A more comprehensive inventory of certain common air pollutants is the National Criteria Air Contaminant Inventory.

It should be noted that air emissions are not a direct indicator of ambient air quality. Emissions are a quantity of a substance that is released to the air from a source, while ambient air quality is a measure of the substances dispersed in the air, and is used to indicate the state of the air. What effect air emissions have on ambient air quality depends on numerous factors including: winds, topography, temperature, precipitation, sunlight and height of the emitting source. Alberta's ambient air quality in 2004 was rated as "good" 97 per cent of the time.

The types and quantities of substances that are reported to the NPRI by a province or territory are greatly affected by the types of industry present, the number and size of facilities that meet the reporting criteria, the sources of electricity generation and the population (which influences the types of industries present and the consumption of electricity). Another important factor is the economic conditions of a province or territory. A growing economy may show increasing emissions, while a steady or shrinking economy may show decreasing emissions.

The Alberta economy contains specialized industries that produce air emissions that are not as prevalent in other parts of Canada. Alberta's economy has also been growing steadily in recent years. In such a heavily resource-based economy, strong economic growth is usually accompanied by increased air emissions. However, according to emission levels of several of the Criteria Air Contaminants reported to the National Pollutant Release Inventory, this has not necessarily been the case for Alberta.

From 2003 to 2004, reported air emissions to the NPRI of volatile organic compounds decreased by 11 per cent, from 92 kilotonnes to 82 kilotonnes. Reported air emissions of total particulate matter also decreased by 11 per cent, from 28 kilotonnes to 25 kilotonnes. Both of these decreases were despite the number of facilities reporting these

substances increasing by 14 per cent. Likewise, sulphur dioxide emissions decreased by one per cent, from 410 kilotonnes to 403 kilotonnes. This was likely due in large part to stricter emissions standards and increased efficiency in the oil and gas extraction, manufacturing and utilities sectors. However, in 2004, Alberta was the greatest emitter of volatile organic compounds in Canada compared to the other provinces and territories and the second largest emitting province of sulphur dioxide emissions reported to the NPRI. This was largely due to the high concentration of oil and gas facilities in Alberta compared to the rest of Canada.

Reported Alberta emissions of carbon monoxide increased by 16 per cent between 2003 and 2004, from 224 kilotonnes to 260 kilotonnes. Over half of the facilities that reported carbon monoxide emissions to the NPRI in 2004 were located in Alberta. Despite this, Alberta was ranked second in Canada for reported carbon monoxide emissions. Reported Alberta emissions of oxides of nitrogen increased three per cent between 2003 and 2004, from 385 kilotonnes to 395 kilotonnes. Alberta had more than 60 per cent of the facilities reporting emissions of oxides of nitrogen and had the largest reported emissions in Canada, due in large part to the conventional oil and gas extraction sector.

Although not specifically categorized as a Criteria Air Contaminant by the NPRI, ammonia is included with these substances in this report. Ammonia was the largest non-Criteria Air Contaminant substance reported by Alberta facilities in 2004. Emissions of ammonia increased by eight per cent between 2003 and 2004, from 8.6 to 9.2 kilotonnes. Alberta had the third greatest number of facilities that reported ammonia emissions but was ranked first in emissions, mainly due to Alberta's large fertilizer industry.

There were 104 other NPRI substances not defined as Criteria Air Contaminants that were reported by Alberta facilities. Alberta facilities reported 20 kilotonnes of non-CAC NPRI substances in 2004. This was the second largest provincial/territorial total in Canada, but was less than half the total quantity reported by Ontario facilities. Total non-CAC NPRI emissions from Alberta facilities increased by 11 per cent from 2003 reported emissions.

Changes in emissions between only two years of data (2003 and 2004) may be partially due to natural fluctuations and reporting variabilities that may have occurred. Longer-term trends for specific substances may show substantially different changes than the change that occurred between 2003 and 2004. Long-term trends are not examined in this report.

Over 90 per cent of the total non-CAC substances reported in 2004 were from facilities in the oil and gas extraction and manufacturing sectors. The non-conventional oil extraction sector accounted for 24 per cent of the non-CAC emissions but represents only six per cent of the facilities that reported. This is due to the large size and high production of most non-conventional oil extraction facilities. The greatest quantities of individual non-CAC substances reported by Alberta facilities for 2004 were carbon disulphide (2.7 kilotonnes), methanol (2.5 kilotonnes) and sulphuric acid (1.9 kilotonnes).

Alberta Environment has a comprehensive *Air Quality Management System* that helps to ensure that air quality in Alberta is protected through a variety of efforts, including

controlling and limiting what is emitted into our air from industrial sources. The management program includes goals and policies, guidelines and standards, monitoring and reporting requirements, regulatory approvals, and the development of a comprehensive emissions inventory for the province. There have also been several policy initiatives developed to manage air emissions and ensure good air quality in Alberta. Some of these policy initiatives include: an *Emissions Management Framework for the Alberta Electricity Sector*, the *Particulate Matter and Ozone Management Framework*, the *Alberta Framework for Management of Acid Deposition*, the *Air Toxics Management Program* and the *Specified Gas Reporting Program* for the reporting of greenhouse gas emissions.

Alberta Environment works with Airshed Management Zones across Alberta to monitor and address air quality issues. Alberta Environment is a founding member of the Clean Air Strategic Alliance, which has helped to develop a number of recommendations on managing air emissions in Alberta. Alberta Environment is also involved in funding research in areas related to management of emissions.

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Abbreviations

AB: Alberta
AQI: Air Quality Index
BC: British Columbia
CAC: Criteria Air Contaminant
CEPA: Canadian Environmental Protection Act
CO: carbon monoxide
EPEA: Environmental Protection and Enhancement Act
kt: kilotonne
MB: Manitoba
N_2O: nitrous oxide
NAICS: North American Industry Classification System
NB: New Brunswick
NH_3: ammonia
NL: Newfoundland and Labrador
Non-CAC: Non-Criteria Air Contaminants
NOx: oxides of nitrogen
NPRI: National Pollutant Release Inventory
NS: Nova Scotia
NT: Northwest Territories
NU: Nunavut Territory
ON: Ontario
PE: Prince Edward Island
PM: particulate matter
PM_{10}: particulate matter less than or equal to 10 micrometres in diameter
$PM_{2.5}$: particulate matter less than or equal to 2.5 micrometres in diameter
PM_{tot}: total particulate matter
QC: Quebec
SK: Saskatchewan
SO_2: sulphur dioxide
VOC: volatile organic compound
YK: Yukon Territory

1.0 Alberta Environment management of air emissions

Substances released to the air can affect the health of the environment, residents, animals and plants. Air emissions are a quantity of a substance that is released to the air from a source. There are a variety of sources that are responsible for air emissions, these include both naturally occurring and man-made. Sources of air emissions include industrial facilities, transportation, home heating, agriculture, forest fires and many others. Emissions reported to the National Pollutant Release Inventory (NPRI) are only from industrial sources. This report focuses only on the reported emissions from industrial sources that meet set criteria and thresholds for reporting to the NPRI. A more comprehensive inventory from all sources of certain common air pollutants is the National Criteria Air Contaminant Inventory (CAC Inventory). The 2002 CAC Inventory is discussed in section 4.5.

The exact impact from an air emission is highly variable and can be difficult to predict. Air emissions do have some influence on air quality, but just because a substance is released to the air, does not mean that air quality will become "poor". The quantity of air emissions is not a direct indicator of air quality. Ambient air quality is the measure of substances dispersed in the air, while emissions are the quantity of a substance coming from a source.

Alberta Environment uses an *Air Quality Index*[i] (AQI) to measure the quality of the air. Using the AQI, the quality of the air is rated as either "good", "fair", "poor" or "very poor" depending on the concentrations of carbon monoxide, nitrogen dioxide, ozone, fine particulate matter ($PM_{2.5}$) and sulphur dioxide measured at monitoring stations.

Alberta Environment has a comprehensive *Air Quality Management System*[ii] that helps to ensure that air quality in Alberta is protected through a variety of efforts that control and limit what is emitted into our air from man-made sources. This management program includes goals and policies, guidelines and standards, monitoring and reporting requirements, regulatory approvals and the development of a comprehensive emissions inventory for Alberta. There are also other management activities that are in place to ensure good air quality in Alberta. The following sections outline the different parts of *Alberta's Air Quality Management System*[ii].

1.1 Goals and policies

The current Alberta target is to maintain "good" air quality 97 per cent of the time, or more, with no "poor" air quality events. Alberta Environment, working with the Clean Air Strategic Alliance, has developed three interrelated goals for the management of air quality. These goals are: to protect the environment, to optimize economic performance and efficiency and to seek continuous improvement.

Alberta Environment has developed several key policies that help to manage industrial air emissions including:

- Ensuring industrial facilities are designed and operate using pollution prevention principles;
- Controlling emissions using the best available control technologies;
- Designing stacks so that there is adequate dispersion of residual emissions to keep ambient concentrations below regulated levels;
- Assessing cumulative impacts of multiple sources;
- Requiring the monitoring of stack emissions and ambient concentrations; and
- Requiring the reporting of monitoring results to the Alberta Government.

1.2 Guidelines and standards

Alberta Environment has developed ambient air quality guidelines for several substances to ensure that the concentrations of these substances found in the air do not reach levels that could impact human or environmental health. The current air quality objectives for Alberta are summarized in *Alberta's Air Quality Objectives Factsheet*[iii].

Ensuring that the quality of the ambient air is within the set guidelines requires that the emissions of some air pollutants be restricted. This is done through regulating industrial sources through the issuing of approvals as set out in the *Environmental Protection and Enhancement Act*[iv]. The approval that a facility is subject to can limit the quantity of certain substances that a facility emits.

The limits placed on the emissions of a facility under an approval are based on a variety of factors including: the existing air quality in the area, ambient air quality guidelines, the nature of the pollutant, the industry involved, the availability of pollution control technologies and the results of plume dispersion modelling. Plume dispersion modelling is a tool that is used to determine the potential impact that a facility could have on the surrounding ambient air quality. This modelling helps to determine the required stack height that would ensure that any residual emissions are properly dispersed to not exceed ambient air quality objectives. This modelling also helps to determine the location of monitoring stations that may be required under an approval.

1.3 Monitoring and reporting

Some facilities in specific industries are required to monitor the ambient air quality for specific pollutants that their facility may be emitting. The approval sets the number of monitoring stations required, the frequency and duration of the monitoring and the techniques and methods that must be used. Alberta Environment, its airshed partners and Environment Canada also operate ambient air quality monitoring stations throughout the province.

Emissions monitoring is also often a requirement in a facility's approval. This in-stack emissions monitoring may be either a manual stack survey or continuous emission monitoring. Manual stack surveys are short duration tests that are conducted in accordance with the reference methods contained in the *Alberta Stack Sampling Code*[v]. Continuous emission monitoring is done with monitoring equipment that are permanently installed on a stack to measure the concentration and flow rate of emissions on a continuous, year round basis. The requirements for continuous emissions monitoring are set out in the *Alberta Continuous Emission Monitoring Systems (CEMS) Code*[vi].

Emissions monitoring may also be required for fugitive sources. Significant quantities of certain pollutants can be emitted from leaking equipment. An approval might set out that a facility is required to implement a monitoring program that would detect leaks in certain equipment.

Reporting goes hand and hand with monitoring activities. Industrial facilities are required to submit monitoring reports to Alberta Environment as specified in their approvals. The reporting requirements can vary depending on the pollutant that is monitored and the type of facility. The reports summarize the ambient and source emissions monitoring data that was collected and provides information on the quality assurance and quality control measures used on the data.

1.4 Regulatory (EPEA) approvals

A key mechanism used by Alberta Environment for implementing the tools of the *Air Quality Management System*[ii] is regulatory approvals that are issued pursuant to the Alberta *Environmental Protection and Enhancement Act*[iv]. Theses approvals use ambient guidelines and source emissions standards along with monitoring and reporting requirements to protect Alberta's air quality.

Approvals can set source emission limits for key pollutants, require the use of pollution control technologies and equipment, require operational procedures that minimize emissions, require stack designs that ensure ambient objectives are met, require that specific monitoring of ambient air and source emissions activities be carried out and that the data is reported to Alberta Environment.

In order to ensure that facilities are complying with the requirements set out in their approvals, inspections of facilities may be carried out. These inspections can include reviewing and following up on monitoring reports, conducting stack surveys and assisting in the development and implementation of abatement strategies to prevent or to minimize potential environment problems.

The strength behind regulatory approvals is the ability to take appropriate legal actions to achieve compliance of the requirements set out in the approval. Alberta Environment has a variety of enforcement tools, which could be used in response to infractions of environmental laws such as approval conditions. These tools include: warning letters,

fines, enforcement orders, administrative penalties, prosecutions, court orders and cancellation of approvals.

1.5 Emissions inventory

In Alberta, emissions inventories are an important part of our *Air Quality Management System*[ii]. In order to be able to successfully identify and address certain air issues, it is necessary to have an accounting of what substances are put into the air from what sources. An emissions inventory is an accounting of pollutant emissions released to the air over a given time and for a given political or geographic region. Inventories can include natural and man-made sources, and can be determined for point (stack) and/or area (total home heating in a region) sources.

Alberta Environment collects emissions data that is reported by many facilities subject to *Environmental Protection and Enhancement Act*[iv] approvals. Over 500 Alberta facilities report some kind of emissions data to Alberta Environment. In addition to what is collected by facilities reporting under their approvals, Alberta Environment has conducted comprehensive inventories of emissions of Criteria Air Contaminants from major industrial operations. The inventories were done every five years in the past, in order assist in the development of the *National Criteria Air Contaminant Inventory*[vii]. Beginning in 2002, Criteria Air Contaminant emissions data was reported to the National Pollutant Release Inventory by facilities across Canada. This has resulted in Alberta Environment discontinuing the 5-year CAC surveys.

In 2003, the Clean Air Strategic Alliance put forth a recommendation that Alberta Environment develop its own comprehensive emissions inventory with an emissions data warehouse. The recommendations were contained in the report put together by the *CASA Data Issues Group*[viii] (2003). The recommendations included:

- Establishing a database for SO_2 atmospheric, source and emission data;
- Ensuring development of improved emissions inventories;
- Improving regional, provincial and national forecasting systems for source emissions; and
- Establishing a central electronic data repository, transfer and clearinghouse system to house air quality data including source emissions, emission forecast information, ambient concentrations, and effects.

Alberta Environment is involved in a pilot project to develop an emissions inventory for the Fort Air Partnership airshed management zone. It is intended that this pilot project could then be used to develop emissions inventories for other airshed zones in the province. Alberta Environment is also in the early stages of developing a province-wide emissions inventory and emissions data warehouse system. Alberta Environment has evaluated two emissions inventory software programs, the *Regional Air Pollution Inventory Development System*[ix] (RAPIDS) and Lakes Environmental's *Emissions View*[x].

Alberta Environment is also partnered with Environment Canada in the One Window to National Environmental Reporting System (OWNERS). OWNERS is an online reporting system that is used by various government agencies and industrial associations to collect environmental data from industrial facilities. The exact system that will be used for data collection and/or storage for an Alberta emissions inventory has not yet been decided. OWNERS is a powerful tool that is being considered along with other inventory systems.

1.6 Other activities

Alberta Environment has been involved in the funding of a variety of projects related to the subject of air emissions. This research will help to enhance the *Air Quality Management System*[ii] in the future. Alberta Environment is a member of all seven airshed management zones that monitor and work on issues related to air quality within their zone.

Alberta Environment is also a founding member of the Clean Air Strategic Alliance (CASA), which was established to help manage air quality issues in Alberta. CASA is a non-profit association that is made up of representatives of government, industry and non-government organizations and works using a consensus-based model. Alberta Environment's involvement with the CASA Pollution Prevention/Continuous Improvement and the Flaring/Venting Project teams have provided a number of recommendations to improve emissions management in Alberta.

As part of its *Air Quality Management System*[ii], Alberta Environment has also helped to develop several other policy initiatives that will help to manage air emissions and ensure that Alberta's air quality remains "good". These include an *Emissions Management Framework for the Alberta Electricity Sector*[xi], the *Particulate Matter and Ozone Management Framework*[xii], the *Alberta Framework for Management of Acid Deposition*[xiii], the *Air Toxics Management Program*[xiv] and the *Specified Gas Reporting Program*[xv] for greenhouse gases.

2.0 About the 2004 industrial (NPRI) emissions data

The National Pollutant Release Inventory (NPRI) is a reporting program administered by Environment Canada. It is mandated under the authority of the *Canadian Environmental protection Act, 1999*[xvi] (CEPA). Owners or operators of facilities that manufacture, process or otherwise use one or more of the NPRI-listed substances greater than the reporting threshold and that meet specific reporting criteria (based on number of employee hours worked and the quantity of a substance emitted) are required to submit a substance report to the NPRI. The information that is reported to the NPRI includes: releases of NPRI substances to the air, land and water; and amounts transferred to other locations for storage, disposal, recycling and energy recovery.

Since it began in 1992, the NPRI list of reportable substances has grown from 178 to 323 for 2004 reporting. These include a variety of substances such as metals and metalloids, respirable mineral fibres, inorganic gases, non-halogenated organic compounds and halogentated organic compounds. There is also a group of substances that are classified as Criteria Air Contaminants (CACs). These are carbon monoxide, oxides of nitrogen (expressed as nitrogen dioxide), total particulate matter, particulate matter less than or equal to 10 micrometres in diameter , particulate matter less than or equal to 2.5 micrometres in diameter , sulphur dioxide and volatile organic compounds (VOCs).

According to the NPRI it is not correct to add Criteria Air Contaminants (which include VOCs) together with other NPRI pollutants because many NPRI pollutants are also volatile organic compounds and this would lead to double counting. For this reason, the analysis of the 2004 industrial air emissions data reported to the NPRI is broken down into non-CAC air emissions (section 3.0) and CAC air emissions (section 4.0). Also, no total for CAC emissions is calculated since total particulate matter includes PM_{10} and $PM_{2.5}$ and PM_{10} includes $PM_{2.5}$ and adding these would lead to double counting.

There are often changes to the NPRI reporting requirements that occur between the reporting years. These changes can include the addition or removal of substances, removals of exemptions for industries to report and changes to the reporting thresholds or rules. There were no significant changes to the NPRI reporting requirements between 2003 and 2004 reporting. The result of this is that the emissions reported to the NPRI for 2003 and 2004 are more comparable than the emissions in other years.

The NPRI emissions data may show increases or decreases in emissions in 2004 from past years due to more than just actual increases or decreases in the reported emissions by facilities. Changes in reported emissions may be due to new facilities reporting to the NPRI, previous reporting facilities no longer meeting the reporting criteria, facilities using improved emission estimation methods, the implementation of pollution control technologies or changes to the operation of facilities (maintenance, shutdowns, expansions, etc).

The NPRI is not a comprehensive inventory of all the releases to the environment, but simply an inventory of reported industrial emissions. This report examines only on-site air releases, which the *Guide for Reporting to the National Pollutant Release Inventory for 2004*[xvii] defines as "a release of pollutants to the air at the facility site" (60) including "releases through the stack, from storage or handling, from fugitive sources such as leaks from valves seals and connections, spills and other non-point releases" (61). It does therefore not include the reported releases to water or the land and does not include transfers, disposals, recycling or energy recovery.

3.0 Non-CAC air emissions

There were 323 reportable substances listed for the 2004 NPRI reporting year. Of these, 316 of them are non-Criteria Air Contaminants (non-CAC), however ammonia is classified as a Criteria Air Contaminant substance in this report. These non-CAC substances include a variety of emitted materials such as: metals and metalloids, respirable mineral fibres, inorganic gases, non-halogenated organic compounds and halogentated organic compounds. Emissions data for these substances is needed to:

- Permit tracking of trends in emissions of these substances,
- Assess the effectiveness of pollution control and reduction programs,
- Identify emissions issues that may require future action,
- Provide information necessary for continued and future program development, and
- Support air quality management programs.

The analysis contained in this section focuses only on non-CAC air emissions (excluding ammonia). Different groupings of non-CAC substances have different reporting thresholds and requirements. Some facilities voluntarily reported emissions to the NPRI even though they did not meet the reporting thresholds or criteria. The voluntary reporting facilities are included in this report. The complete reporting guidelines for both CAC and non-CAC substances are detailed in the *Guide for Reporting to the National Pollutant Release Inventory 2004*[xvii]. Analysis of CAC emissions (including ammonia) is found in section 4.0 of this report.

3.1 Non-CAC substances

There were 323 substances that the NPRI listed as substances that could be reported in 2004. Of these, 104 NPRI substances (excluding seven CACs and ammonia) were reported to the NPRI by Alberta facilities in 2004. Table 10 in the appendix details the total quantities of each of the reported substance that were emitted. The greatest quantities of individual non-CAC substances reported by Alberta facilities for 2004 were carbon disulphide (2.7 kilotonnes), methanol (2.5 kilotonnes) and sulphuric acid (1.9 kilotonnes). The total of Alberta non-CAC air emissions in 2004 was 20 kt, which was an increase of 11 per cent from the previous year.

3.2 Non-CAC industrial sources

There were 261 Alberta facilities that reported non-CAC releases to the NPRI in 2004. Figure 1 shows the number of facilities per industrial sector reporting non-CAC NPRI substances. Of these facilities, 101 of them were in the manufacturing sector and 94 were in the conventional oil and gas extraction sector. The utilities, transportation and warehousing, wholesale trade and non-conventional oil and gas extraction sectors each had between 10 and 15 facilities reporting NPRI substances (non-CAC). The other industrial sectors each had fewer than 10 facilities reporting non-CAC emissions.

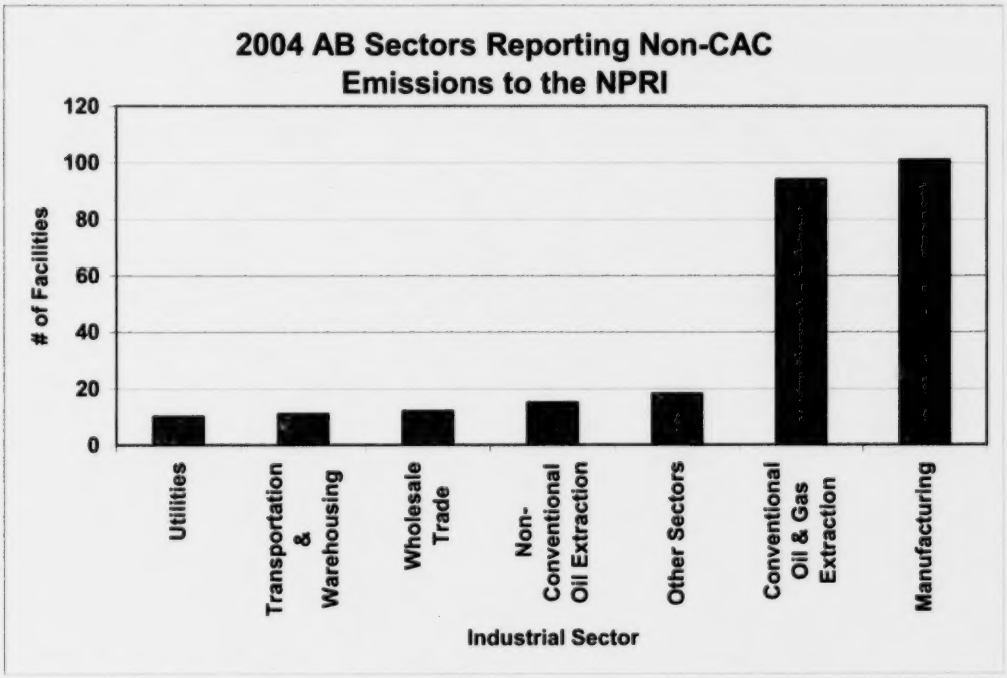

Figure 1: Alberta facilities reporting non-CAC emissions to the NPRI for 2004.

Figure 2 shows the total quantities of Alberta non-CAC emissions reported to the NPRI in 2004 by industrial sector. The largest sources of reported emissions were from facilities in the manufacturing and conventional oil and gas extraction sectors. Each sector reported emissions of approximately 6.5 kt or 33-34 per cent of total reported non-CAC emissions. These sectors also had the most facilities reporting non-CAC emissions to the NPRI, which likely made their total non-CAC emissions higher. The third largest source was the non-conventional oil extraction sector, with 4.7 kt or 24 per cent of reported emissions. The non-conventional oil extraction sector had the next largest number of facilities reporting but still had 24 per cent of the reported emissions, as facilities in the sector tend to be very large and complex. The utilities sector was responsible for 1.7 kt or nine per cent of reported emissions. The remaining industrial sectors together contributed to less than one per cent of total reported non-CAC emissions.

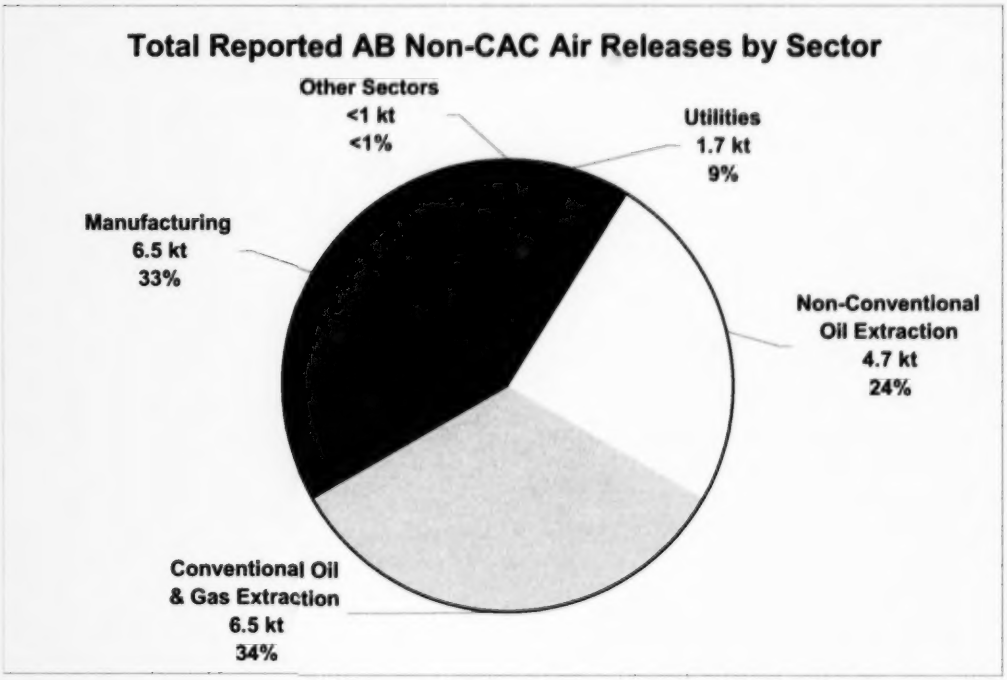

Figure 2: 2004 total reported Alberta non-CAC emissions by sector.

3.3 Comparison to 2003 emissions

The 261 Alberta facilities that reported non-CAC substances to the NPRI in 2004 were more than the 248 facilities that reported in 2003. The 1,460 reported releases from the 261 facilities are also up from the 1,430 reported releases from the 248 facilities reporting in 2003. The 20 kt of NPRI substances released to the air by Alberta facilities in 2004 was an increase of 11 per cent from the 18 kt reported for 2003. Caution should be taken when comparing just two years of emissions data, as changes may be partially due to

natural fluctuations and reporting variabilities that may have occurred. Longer-term trends for specific substances may show substantially different changes than the change that occurred between 2003 and 2004 for total reported non-CAC emissions. Long-term trends are not examined in this report.

3.4 Provincial comparison

Figure 3 shows the total non-CAC air emissions by province and territory reported to the NPRI for 2004. Ontario had the largest total reported non-CAC air emissions in 2004, with about 43 kt or about 40 per cent of reported emissions to the NPRI. Alberta had the second largest total, with about 20 kt or about 19 per cent of reported emissions. Alberta's non-CAC emissions are much lower than Ontario's, primarily due to fewer manufacturing facilities being located in Alberta. The kind of industrial operations present in a jurisdiction determines the types and quantities of pollutants released to the air. Facilities in Quebec were the third largest emitters of total reported non-CAC air emissions with about 16 kt (15 per cent), followed by British Columbia with about 12 kt (11 per cent). The remaining provinces and territories each reported emissions of less than five per cent of total reported non-CAC emissions.

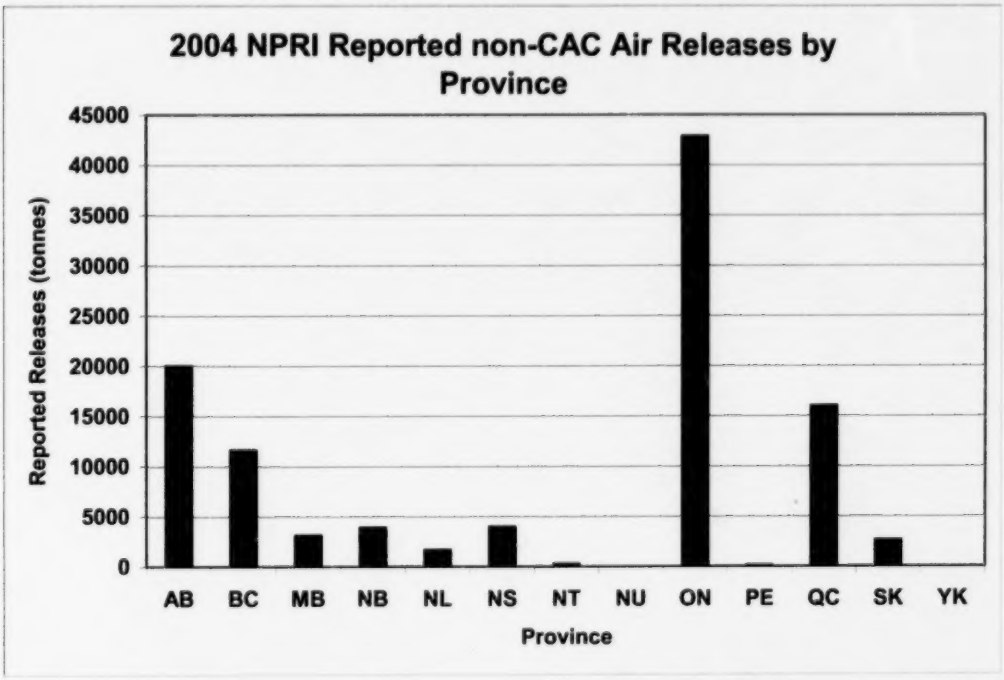

Figure 3: 2004 reported non-CAC emissions by province/territory.

Table 1 shows the changes in total reported non-CAC air emissions between 2003 and 2004 for each province and territory. Alberta saw the largest absolute change and increase of any province or territory between 2003 and 2004. Total reported Alberta non-CAC air emissions increased by nearly two kt, which was a change of about 11 per cent from 2003. The second largest increase was seen by Saskatchewan, which saw reported emissions rise by 0.5 kt or 25 per cent. The largest decrease between 2003 and 2004 was seen by British Columbia, which decreased by nearly two kt or about 14 per cent of their 2003 emissions. The total reported non-CAC emissions for all of Canada saw a net decrease of about 1.3 kt or one per cent of 2003 emissions. The increases in reported emissions that were seen by Alberta, Manitoba, Newfoundland and Labrador, the Northwest Territories, Prince Edward Island and Saskatchewan were offset by the decreases in reported emissions seen by British Columbia, New Brunswick, Nova Scotia, Nunavut, Ontario and Quebec.

Table 1: 2003-2004 non-CAC air emissions changes by province/territory.

Province*	2004 Non-CAC Emissions	2003 Non-CAC Emissions	Difference	Per cent Change
AB	20,011.33	18,048.362	1,962.968	11
BC	11,595.99	13,510.458	-1,914.468	-14
MB	3,082.166	2,625.078	457.088	17
NB	3,868.868	4,923.253	-1,054.385	-21
NL	1,654.005	1,587.503	66.502	4
NS	3,978.394	4,006.954	-28.560	-1
NT	232.6034	203.728	28.875	14
NU	0	33.332	-33.332	-100
ON	42,852.59	43,790.770	-938.180	-2
PE	83.429	77.394	6.035	8
QC	15,989.07	16,418.201	-429.131	-3
SK	2,606.174	2,092.409	513.765	25

* Non-CAC emissions were not reported to the NPRI by any facilities in the Yukon Territory in 2003 or 2004.

4.0 CAC air emissions

Criteria Air Contaminants (CAC) are air pollutants that are commonly released into the air by various sources. The NPRI identifies seven substances as CACs including: carbon monoxide, oxides of nitrogen, total particulate matter, particulate matter less than or equal to 10 micrometres in diameter, particulate matter less than or equal to 2.5 micrometres in diameter, sulphur dioxide and volatile organic compounds. Although not specifically identified as a CAC substance, ammonia is included with the seven CAC substances in the analysis used in this report. These eight substances are key contributors to poor air quality and smog.

4.1 CAC substances

Environment Canada began collecting CAC emissions data through the NPRI in 2002. A key reason for adding CAC substances to the NPRI reporting requirements was to aid in the development of the *National Criteria Air Contaminant Emissions Inventory*[xvii]. CAC emissions information is needed to assess how effective programs designed at reducing emissions have been. They are also needed to support various policy initiatives and jurisdictional agreements such as the:

- *Canada-wide Standards for PM and Ozone*[xviii],
- *Alberta framework for management of acid deposition*[xiii],
- Management of regional air quality, and
- Informing the public.

Provided that set reporting criteria are met, substance reports are required for the seven CAC substances and ammonia. The reporting thresholds and criteria of the seven CAC substances differ from those of the different groupings of non-CAC substances (and ammonia). The complete reporting guidelines for both CAC and non-CAC substances are detailed in the *Guide for Reporting to the National Pollutant Release Inventory 2004*[xvii].

Table 2 shows the reporting threshold for each CAC and ammonia. Some facilities voluntarily reported emissions to the NPRI even though they did not meet the reporting thresholds or criteria. The voluntary reporting facilities are included in this report. The 2004 total reported emissions of each CAC from Alberta facilities is shown in Table 9 of the appendix. The analysis contained in this section of the report focuses only on CAC air emissions (including ammonia). Analysis of non-CAC emissions (excluding ammonia) is found in section 3.0 of this report.

Table 2: 2004 NPRI CAC reporting thresholds.

CAC Substance	NPRI Reporting Threshold
Sulphur dioxide	20 tonnes
Oxides of nitrogen (expressed as NO_2)	20 tonnes
Carbon monoxide	20 tonnes
Ammonia	10 tonnes
Total particulate matter	20 tonnes
Particulate matter less than 10 microns	0.5 tonnes
Particulate matter less than 2.5 microns	0.3 tonnes
Volatile organic compounds	10 tonnes

4.1.1 Sulphur dioxide

Sulphur dioxide (SO_2) is a colourless gas with a pungent odour and is formed when sulphur is oxidized and emitted to the atmosphere. SO_2 is emitted when fuels that contain sulphur (such as coal and oil) are burned. SO_2 is also emitted during various other industrial processes. SO_2 is a precursor to the formation of particulate matter and, subsequently, smog. SO_2 emissions can also be a contributor to acid rain.

There were 246 Alberta facilities that reported sulphur dioxide emissions to the NPRI in 2004. These emissions totaled 403 kt. Figure 4 shows the major Alberta industrial sources of sulphur dioxide emissions reported to the NPRI in 2004. The SO_2 emissions reported by Alberta facilities in 2004 ranged from smaller than one tonne to just over 78,000 tonnes. The 2004 average per facility reported SO_2 emission was 1,640 tonnes.

Three industrial sectors were responsible for over 95 per cent of the total reported Alberta sulphur dioxide emissions. Facilities in the conventional oil and gas extraction sector were the source of the largest portion of reported sulphur dioxide emissions released to the air, with 140 kt or 35 per cent of total reported SO_2 emissions. Facilities in the utilities sector were the source of the second largest amount of reported sulphur dioxide emissions released to the air, with 129 kt or 32 per cent of total reported SO_2 emissions. Facilities in the non-conventional oil extraction sector were the other major industrial source of reported SO_2 emissions, with 117 kt or 29 per cent of total reported SO_2 emissions. The remaining 18 kt, or four per cent of total reported sulphur dioxide emissions, were from facilities in other sectors.

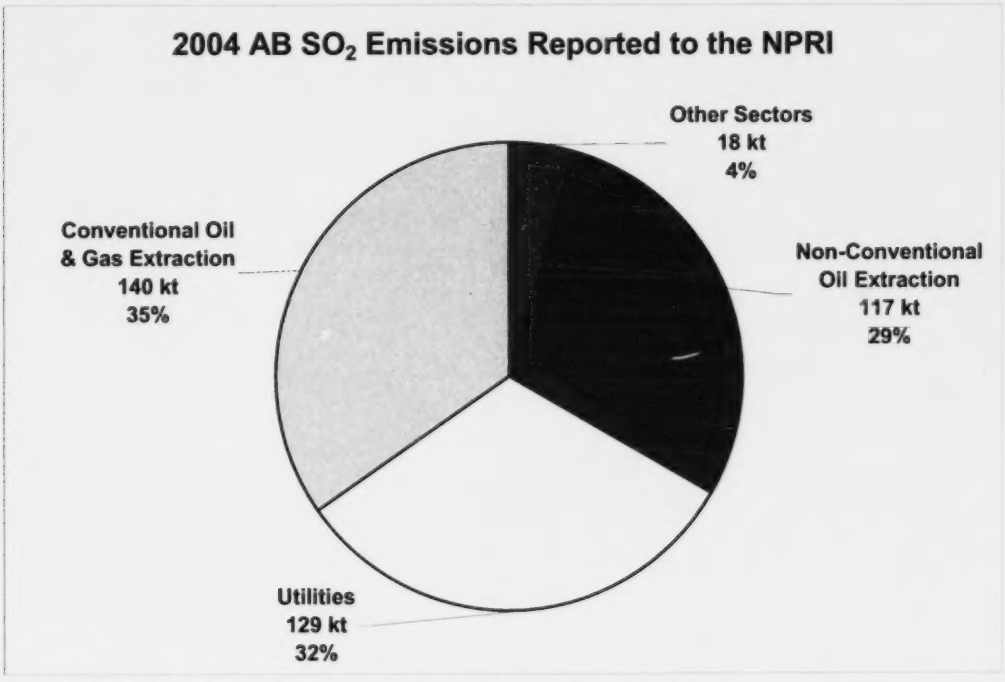

Figure 4: 2004 reported Alberta sulphur dioxide emissions.

4.1.2 Oxides of nitrogen

Oxides of nitrogen (NOx) are the total of nitrogen dioxide (NO_2) and nitric oxide (NO). NOx is formed when nitrogen and oxygen combine at high temperatures. The combustion of fossil fuels and various industrial processes can produce NOx. NOx is a precursor to the formation of ozone, which can cause declines in air quality. NOx emissions can also be a contributor to acid rain.

There were 2,243 Alberta facilities that reported emissions of oxides of nitrogen to the NPRI in 2004. These emissions totaled 395 kt. Figure 5 shows the major Alberta industrial sources of NOx emissions reported to the NPRI in 2004. The NOx emissions reported by Alberta facilities in 2004 ranged from smaller than one tonne to just over 25,000 tonnes. The average per facility reported NOx emission was 176 tonnes.

Facilities in the conventional oil and gas extraction sector were responsible for over half of the reported Alberta NOx emissions. Facilities in this sector reported total NOx emissions of 221 kt, or 57 per cent of total reported NOx emissions. Facilities in the utilities sector were responsible for the second largest portion of reported NOx emissions, with 96 kt or 24 per cent of reported NOx emissions. Manufacturing facilities were the next largest source of reported NOx emissions, with 33 kt or eight per cent of reported emissions. Facilities in the non-conventional oil extraction sector were the other major source of NOx emissions, with 32 kt, or eight per cent of reported NOx emissions. The remaining 14 kt, or three per cent of reported NOx emissions, were from facilities in other sectors.

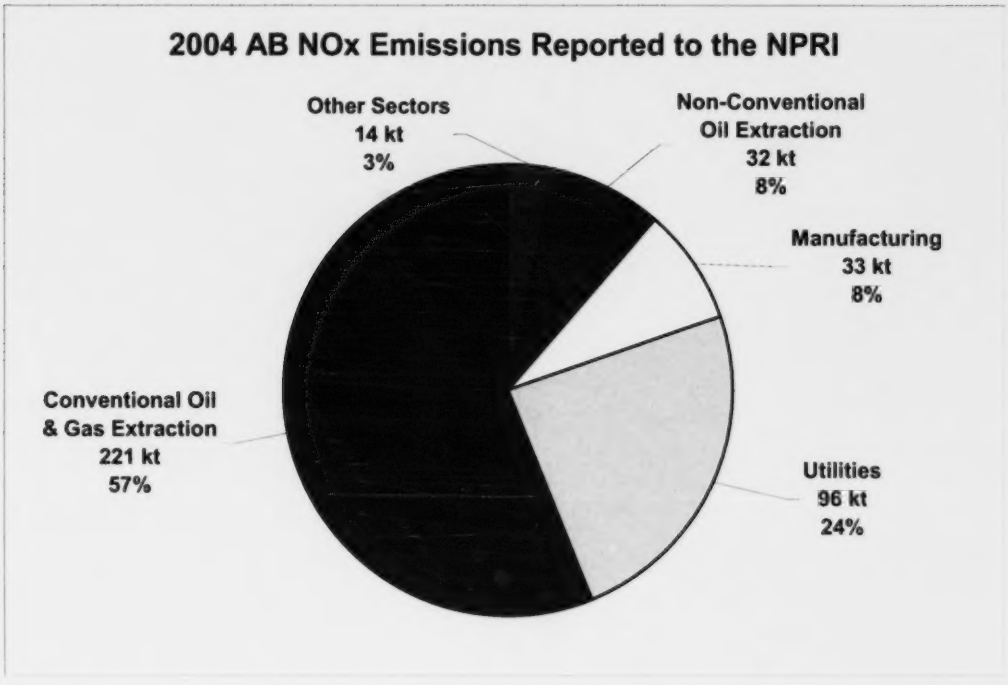

Figure 5: 2004 reported Alberta emissions of oxides of nitrogen.

4.1.3 Carbon monoxide

Carbon monoxide (CO) is a colourless, odourless, poisonous gas that is formed during the incomplete combustion of fossil fuels. Other sources beside combustion of fossil fuels include various industrial processes. There were 1,487 Alberta facilities that reported CO emissions in 2004. These emissions totaled 260 kt. Figure 6 shows the major Alberta industrial sources of CO emissions reported to the NPRI in 2004. The CO emissions reported by Alberta facilities in 2004 ranged from smaller than one tonne to nearly 28,000 tonnes. The average per facility reported CO emission was 175 tonnes.

Facilities in the conventional oil and gas extraction sector were responsible for nearly half (45 per cent) of reporting CO emissions with 115 kt. Manufacturing facilities were the source of the second largest portion of reported CO emissions, with 77 kt or 29 per cent of reported CO emissions. Non-conventional oil extraction facilities were the third largest source of reported CO emissions, with 39 kt or 15 per cent of reported CO emissions. Utilities facilities were the other major source of reported CO emissions, with 24 kt or nine per cent of reported CO emissions. The remaining five kt, or two per cent of reported CO emissions, were from facilities in other sectors.

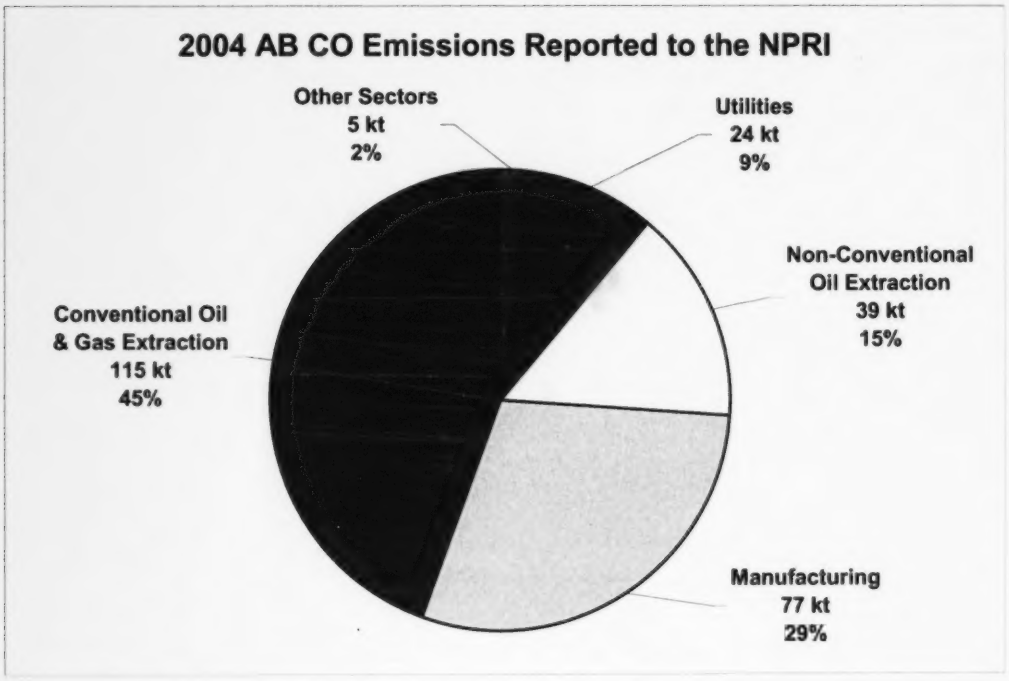

Figure 6: 2004 reported Alberta carbon monoxide emissions.

4.1.4 Ammonia

Ammonia (NH_3) is a colourless gas with a pungent odour. Major sources of ammonia emissions include the fertilizer industry and commercial feedlots. Although ammonia is not specifically listed as a Criteria Air Contaminant in the NPRI, it is included with the seven Criteria Air Contaminants substances to be consistent with the *National Criteria Air Contaminant Inventory*[vii] and because it is a contributing factor to poor air quality and smog. Its inclusion here is not meant to diminish its impact - if ammonia releases were included with the non-CAC substances, it would be the largest reported non-CAC emission quantity.

There were 35 Alberta facilities that reported ammonia emissions to the NPRI in 2004. These emissions totaled 9.2 kt. Figure 7 shows the major Alberta industrial sources of NH_3 emissions reported to the NPRI in 2004. The NH_3 emissions reported by Alberta facilities in 2004 ranged from smaller than one tonne to nearly 2,300 tonnes. The average per facility reported NH_3 emission was 264 tonnes.

Manufacturing facilities were responsible for more than three-quarters (78 per cent) of ammonia emissions, with 7.2 kt. Facilities in the non-conventional oil extraction sector were the second largest source of reported NH_3 emissions, with 1.4 kt or 15 per cent of total reported NH_3 emissions. Utilities facilities were the other major source of reported NH_3 emissions, with 0.6 kt or six per cent of reported NH_3 emissions. The remaining 0.1 kt, or one per cent of reported NH_3 emissions, were from facilities in other sectors.

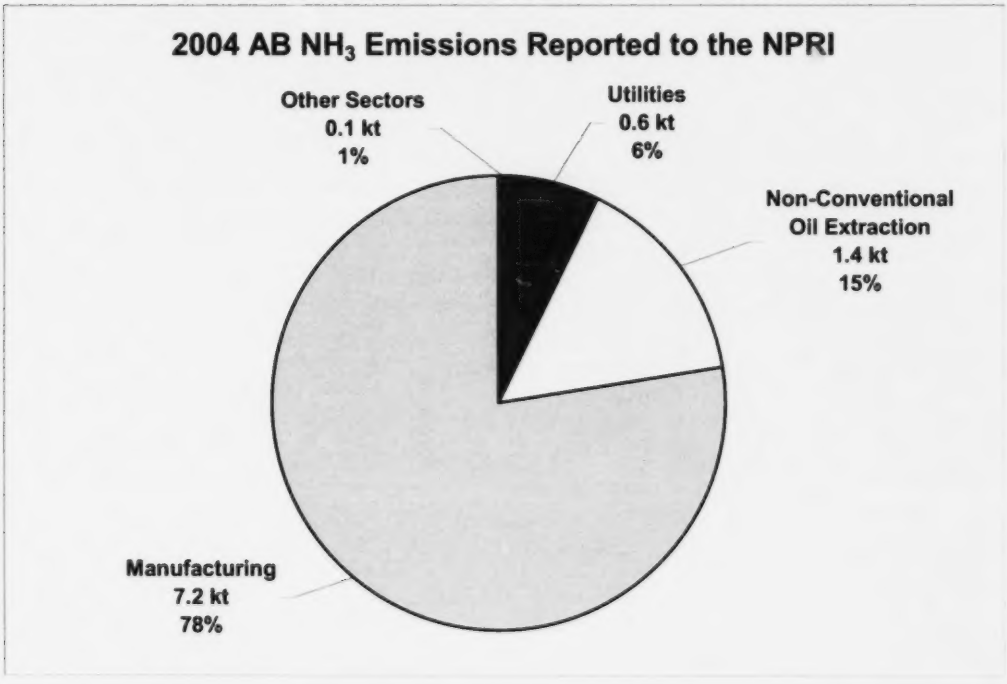

Figure 7: 2004 reported Alberta ammonia emissions.

4.1.5 Total particulate matter

Total particulate matter (PM_{tot}) is any particulate matter that has a diameter of smaller than or equal to 100 micrometres. Particulate matter is solid particles that are found in the air. Particulate matter may be released directly into the atmosphere or formed in the atmosphere as a result of physical or chemical transformations of precursors. Particulate matter is formed in various industrial processes. Some common sources of particulate matter include combustion of fossil fuels, industrial separation processes, land treatment, storage piles and mine tailings. Particulate matter in the atmosphere can reduce visibility and form smog. Some particulate matter can be inhaled and cause respiratory problems.

There were 156 Alberta facilities that reported total particulate matter emissions to the NPRI in 2004. These emissions totaled 24.7 kt. Figure 8 shows the major Alberta industrial sources of PM_{tot} emissions reported to the NPRI in 2004. The PM_{tot} emissions reported by Alberta facilities in 2004 ranged from smaller than one tonne to 3,100 tonnes. The average per facility reported PM_{tot} emission was 159 tonnes.

Manufacturing facilities were responsible for the largest portion of reported PM_{tot} emissions, with 9.6 kt or 38 per cent of reported emissions. Utilities facilities were the next largest contributing sector, with 9.3 kt or 38 per cent of total PM_{tot} emissions. Facilities in the non-conventional oil extraction sector were the other major source of reported PM_{tot} emissions, with 3.6 kt or 15 per cent of reported emissions. The remaining 2.2 kt, or nine per cent of total reported PM_{tot} emissions, were from facilities in other sectors.

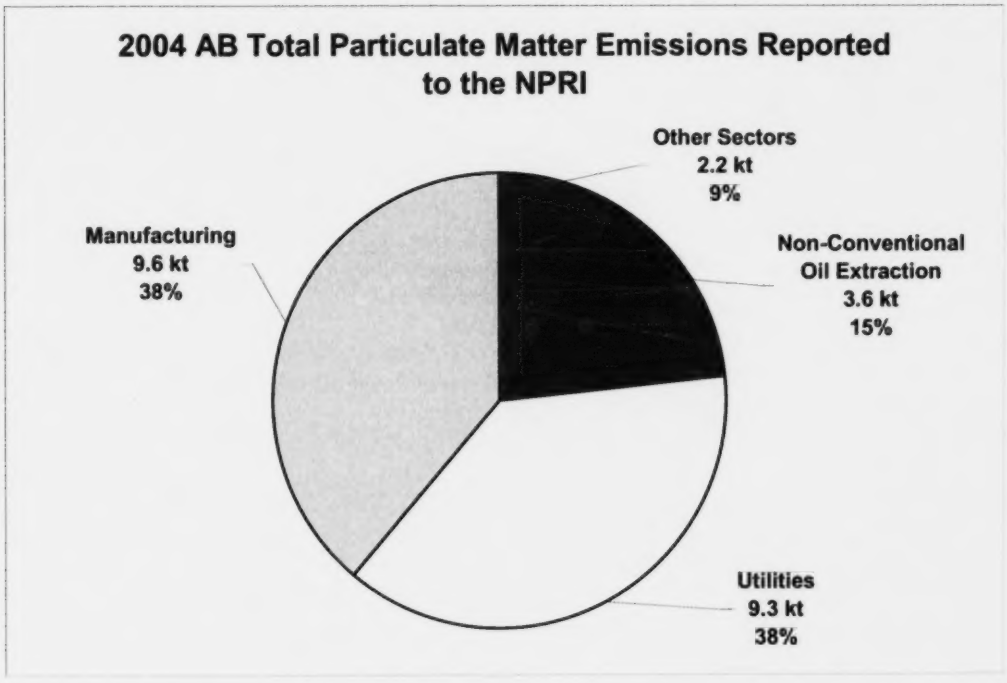

Figure 8: 2004 reported Alberta total particulate matter emissions.

4.1.6 Particulate matter equal to or smaller than 10 micrometres in diameter

Particulate matter less than or equal to 10 micrometres in diameter (PM_{10}) is any particulate matter that has a diameter less than or equal to 10 micrometres. Particulate matter is solid particles that are found in the air. Particulate matter may be released directly into the atmosphere or formed in the atmosphere as a result of physical or chemical transformations of precursors. Particulate matter is formed in various industrial processes. Some common sources of particulate matter include combustion of fossil fuels, industrial separation processes, land treatment, storage piles and mine tailings. Particulate matter in the atmosphere can reduce visibility and form smog. Some particulate matter can be inhaled and may cause respiratory problems.

There were 1,047 Alberta facilities that reported PM_{10} emissions to the NPRI in 2004. These emissions totaled 17.5 kt. Figure 9 shows the major Alberta industrial sources of PM_{10} emissions reported to the NPRI. The PM_{10} emissions reported by Alberta facilities in 2004 ranged from smaller than one tonne to 2,300 tonnes. The average per facility reported PM_{10} emission was 17 tonnes.

Facilities in the utilities sector were responsible for the largest portion of total reported PM_{10} emissions, with 6.2 kt or 36 per cent of total reported PM_{10} emissions. Manufacturing facilities were responsible for the second largest portion of total PM_{10} emissions, with 6.0 kt or 34 per cent of reported emissions. Non-conventional oil extraction facilities together contributed to the third largest portion of reported PM_{10} emissions, with 2.5 kt or 14 per cent of reported emissions. Conventional oil and gas extraction facilities were the other major source of reported PM_{10} emissions with, 1.9 kt or 11 per cent of reported PM_{10} emissions. The remaining 0.9 kt, or five per cent of reported PM_{10} emissions, were from facilities in other sectors.

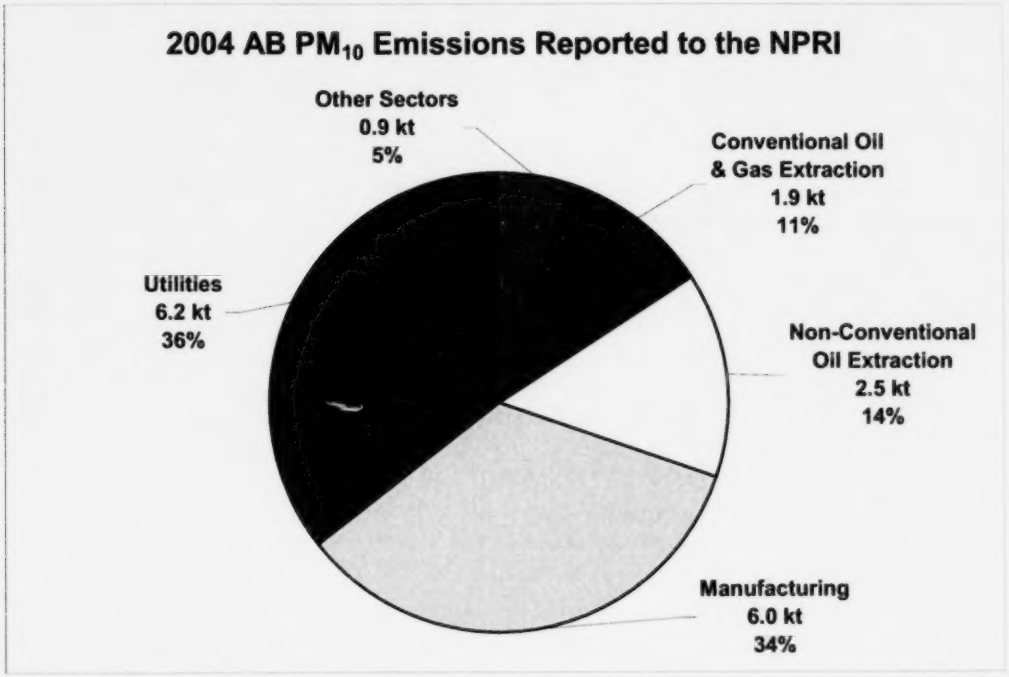

Figure 9: 2004 reported Alberta PM_{10} emissions.

4.1.7 Particulate matter equal to or smaller than 2.5 micrometres in diameter

Particulate matter less than or equal to 2.5 micrometres in diameter ($PM_{2.5}$) is any particulate matter that has a diameter of less than or equal to 2.5 micrometres. Particulate matter is solid particles that are found in the air. Particulate matter may be released directly into the atmosphere or formed in the atmosphere as a result of physical or chemical transformations of precursors. Particulate matter is formed in various industrial processes. Some common sources of particulate matter include combustion of fossil fuels, industrial separation processes, land treatment, storage piles and mine tailings. Particulate matter in the atmosphere can reduce visibility and form smog. Some particulate matter can be inhaled and may cause respiratory problems.

There were 1,405 Alberta facilities that reported $PM_{2.5}$ emissions to the NPRI in 2004. These emissions totaled 10.2 kt. Figure 10 shows the major Alberta industrial sources of $PM_{2.5}$ emissions reported to the NPRI in 2004. The $PM_{2.5}$ emissions reported by Alberta facilities in 2004 ranged from smaller than one tonne to 900 tonnes. The average per facility reported $PM_{2.5}$ emission was seven tonnes.

Facilities in the manufacturing sector contributed the largest portion of $PM_{2.5}$ emissions, with 3.5 kt or 35 per cent of reported emissions. Facilities in the utilities sector contributed the second largest portion of reported $PM_{2.5}$ emissions, with 3.2 kt or 31 per cent of reported emissions. Conventional oil and gas extraction facilities contributed the third largest portion of reported $PM_{2.5}$ emissions, with 1.6 kt or 15 per cent of reported emissions. Non-conventional oil extraction facilities were the other major source of reported $PM_{2.5}$ emissions, with 1.3 kt or 13 per cent of reported emissions. The remaining 0.6 kt, or six per cent of reported $PM_{2.5}$ emissions, were from facilities in other sectors.

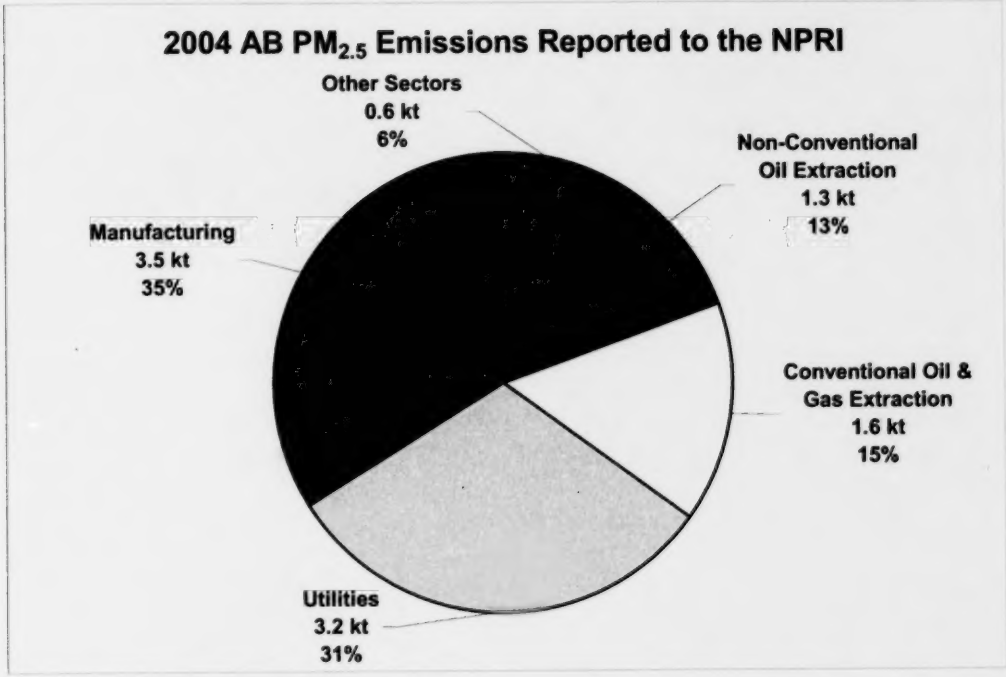

Figure 10: 2004 reported Alberta $PM_{2.5}$ emissions.

4.1.8 Volatile organic compounds

Volatile organic compounds (VOCs) are an aggregate grouping of about 1,000 organic substances that readily dissipate. Some VOCs can undergo photochemical reactions in the atmosphere and contribute to the formation of particulate matter and ozone. There are many sources of VOCs, such as loading and unloading of petroleum products, petroleum spills, process venting, spill remediation, flaring of untreated natural gas, evaporative losses from storage tanks, painting and stripping activities, degreasing activities, burning fuel and the use of solvents and wood preservatives.

There were 424 Alberta facilities that reported VOC emissions to the NPRI in 2004. These emissions totaled 82.0 kt. Figure 11 shows the major Alberta industrial sources of VOC emissions reported to the NPRI in 2004. The VOC emissions reported by Alberta facilities in 2004 ranged from smaller than one tonne to nearly 22,000 tonnes. The average per facility reported VOC emission was 193 tonnes.

Half of all the reported VOC emissions were from non-conventional oil extraction facilities, totaling 40.9 kt. Conventional oil and gas extraction facilities were the second largest contributors to total reported VOC emissions, with 18.3 kt or 22 per cent of reported emissions. Manufacturing facilities were responsible for the third largest share of reported VOC emissions, with 17.3 kt or 21 per cent of reported emissions. The remaining 5.5 kt, or seven per cent of reported VOC emissions, were from facilities in other sectors.

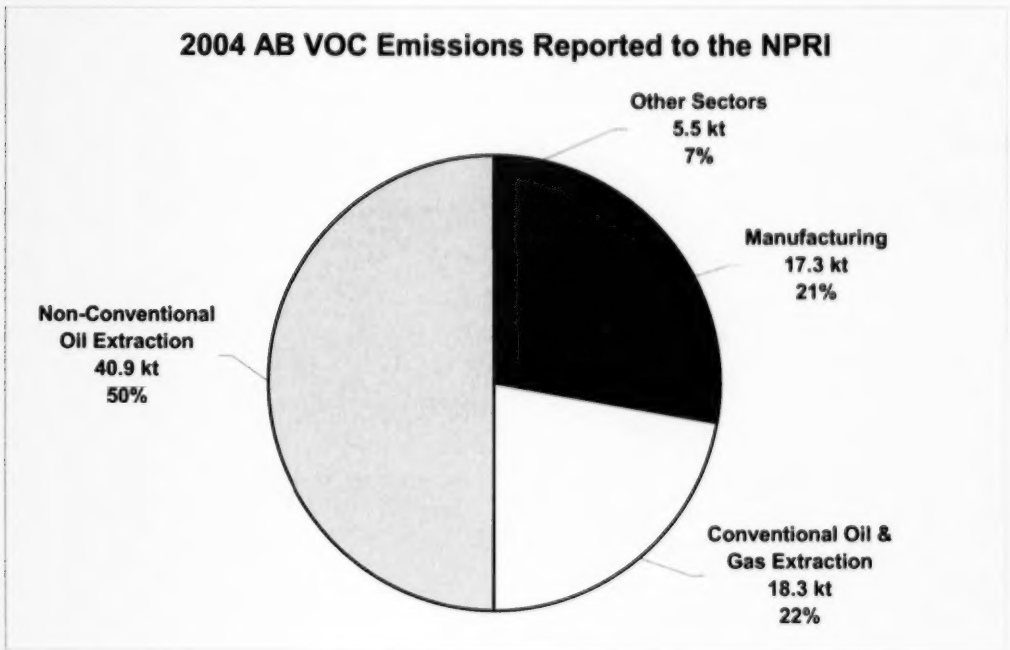

Figure 11: 2004 reported Alberta volatile organic compound emissions.

4.2 CAC industrial sources

Facilities reporting to the NPRI are required to provide information on what industrial sector they belong to. One way they do this is by provided a North American Industry Classification System (NAICS) code. These are two, four and six-digit codes that classify a facility according to standardized sector codes. The two-digit codes are very broad, four-digit more specific and six-digit very specific. There are however some differences in the six-digit NAICS codes used in Canada and the United States.

The major sources of 2004 CAC emissions reported to the NPRI were from the conventional oil and gas extraction, non-conventional oil extraction, manufacturing and utilities sectors. Sections 4.21 - 4.24 contain detailed analysis of the CAC emissions from these sectors. The definitions of the NAICS codes used in this report can be found in the Appendix. Further detailed information on all Canadian NAICS codes is available from *Statistics Canada*[xix].

4.2.1 Conventional oil and gas extraction

All seven Criteria Air Contaminants and ammonia (NH_3) were reported by Alberta facilities in the conventional oil and gas sector in 2004. Facilities often reported more than one Criteria Air Contaminant being released. Figure 12 shows the number of Alberta facilities reporting each CAC in the conventional oil and gas extraction sector. Emissions of oxides of nitrogen (NOx) were the most common CAC reported by facilities in the conventional oil and gas extraction sector. There were 1,888 facilities reporting NOx compared with 1,190 facilities reporting carbon monoxide (CO) emissions. Emissions of particulate matter equal to or smaller than 2.5 micrometres in diameter ($PM_{2.5}$) were reported by 1,055 facilities, while emissions of particulate matter equal to or smaller than 10 micrometres in diameter (PM_{10}) emissions were reported by 711 facilities. Emissions of volatile organic compounds (VOC) were reported by 253 facilities, while sulphur dioxide (SO_2) emissions were reported by 175 facilities. Emissions of total particulate matter (PM_{tot}) were reported by 22 facilities and ammonia emissions were also reported, but only by one facility.

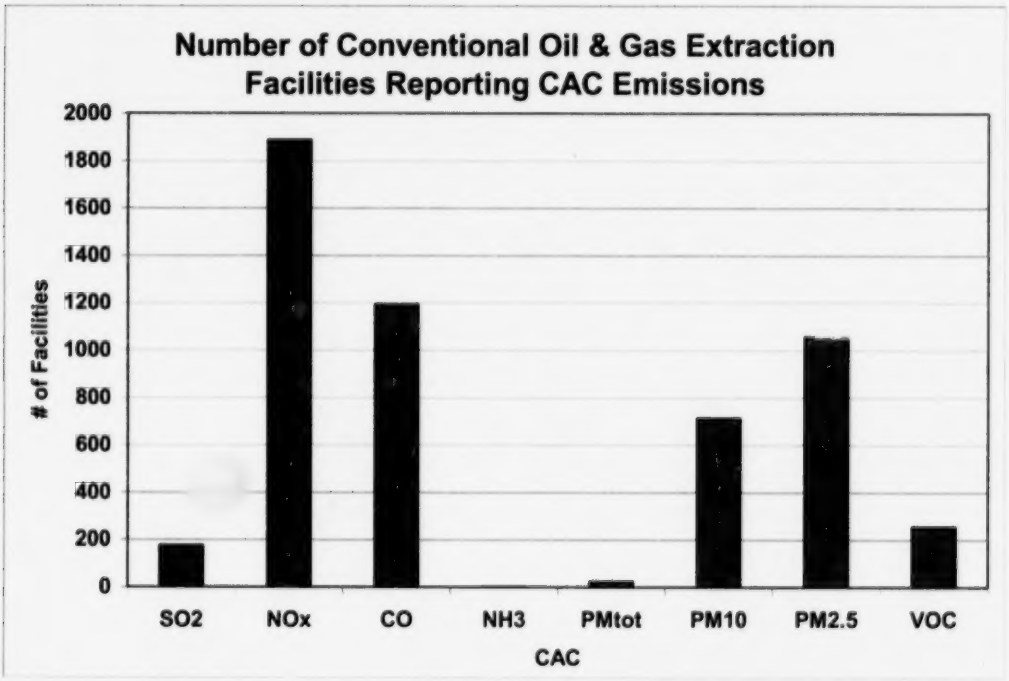

Figure 12: Number of Alberta conventional oil and gas extraction facilities reporting CAC emissions.

Figure 13 shows the quantity of CAC emissions emitted by Alberta facilities in the conventional oil and gas extraction sector. NOx was the most common CAC emission reported in this sector and had the largest reported emissions of any CAC substance, with 221.4 kt. Sulphur dioxide was the second largest reported CAC emission in the conventional oil and gas extraction sector, with 139.7 kt. A total of 115.3 kt of CO emissions were reported, while total reported VOC emissions were 18.3 kt. PM_{10} and $PM_{2.5}$ reported emissions totaled 1.9 and 1.6 kt respectively. Emissions of total particulate matter were 0.7 kt, while NH_3 emissions were less than 0.1 kt, as only one facility in the conventional oil and gas extraction sector reported it.

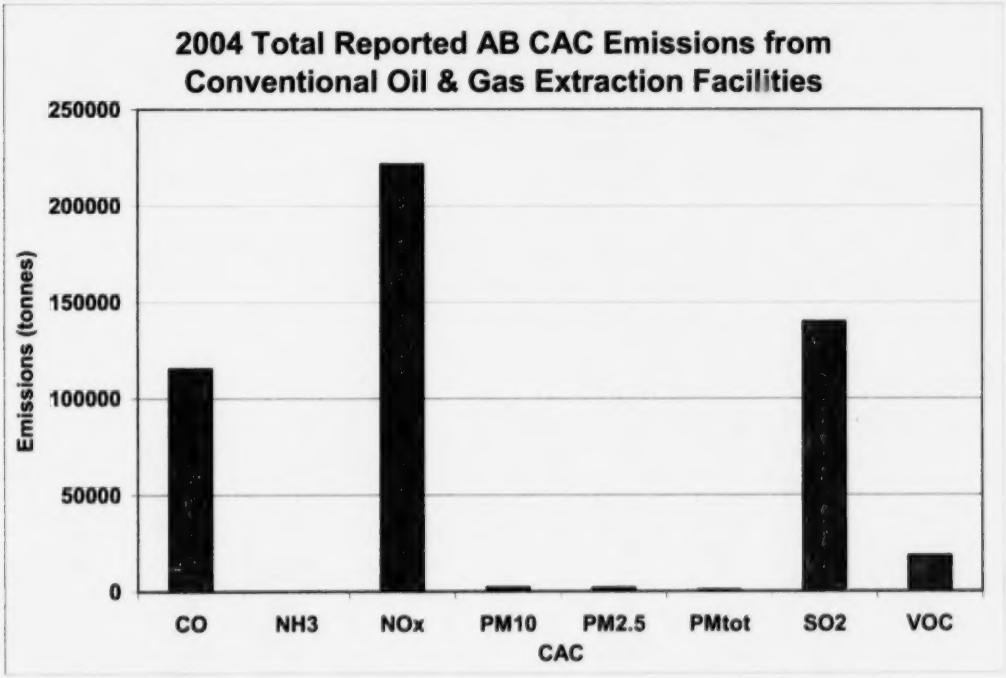

Figure 13: 2004 reported Alberta CAC emissions from conventional oil and gas extraction facilities.

4.2.2 Non-conventional oil extraction

All seven Criteria Air Contaminants and ammonia (NH_3) were reported by facilities in the non-conventional oil extraction sector in 2004. Facilities often reported more than one Criteria Air Contaminant being released. Figure 14 shows the number of Alberta facilities that reported emissions of each CAC in the non-conventional oil extraction sector. Emissions of oxides of nitrogen (NOx) and carbon monoxide (CO) were the most common CACs reported in the non-conventional oil extraction sector. There were 25 facilities that reported each in 2004. The second largest number of facilities in the non-conventional oil extraction sector reported emissions of particulate matter equal to or smaller than 10 micrometres in diameter (PM_{10}) and emissions of particulate matter equal to or smaller than 2.5 micrometres in diameter ($PM_{2.5}$), with 21 facilities reporting each. Emissions of volatile organic compounds (VOC) were reported by 19 facilities and sulphur dioxide (SO_2) emissions were reported by 14 facilities. There were 10 facilities that reported emissions of total particulate matter (PM_{tot}), while three facilities reported ammonia emissions.

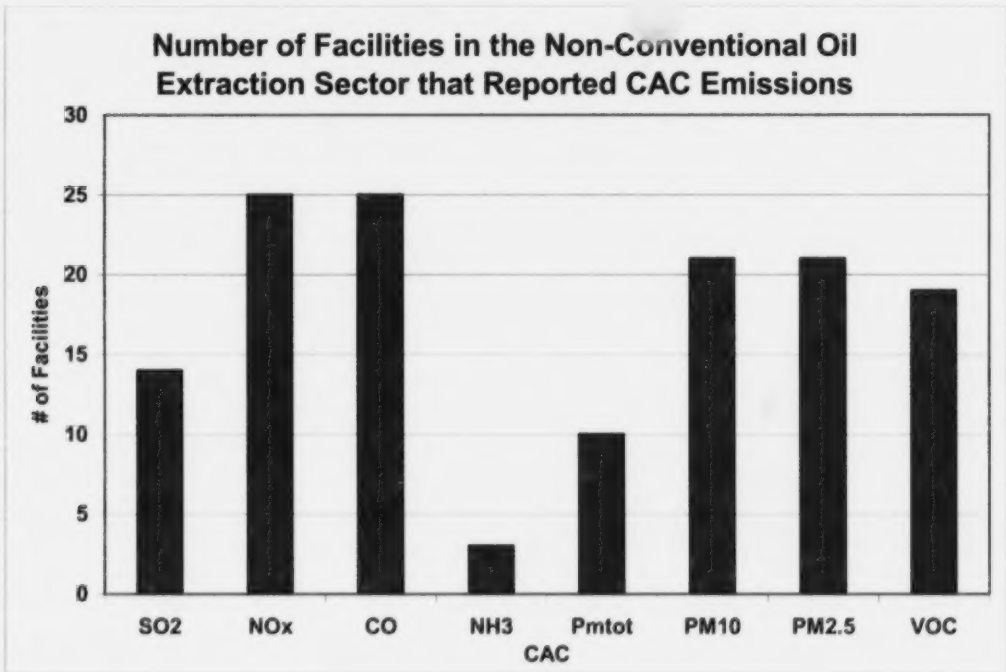

Figure 14: Number of Alberta facilities in the non-conventional oil extraction sector reporting CAC emissions.

Figure 15 shows the total emissions of each CAC from Alberta facilities in the non-conventional oil extraction sector. The largest quantity of reported emissions from non-conventional oil extraction facilities was SO_2 with 116.6 kt. Total VOC emissions were second largest quantity reported with 40.9 kt and reported carbon monoxide emissions were the third largest with 38.8 kt. Total reported NOx emissions from the non-conventional oil extraction sector totaled 31.8 kt, while PM_{tot} emissions were 3.6 kt. Total reported PM_{10} emissions were 2.5 kt, $PM_{2.5}$ emissions 1.3 kt and NH_3 emissions were 1.4 kt.

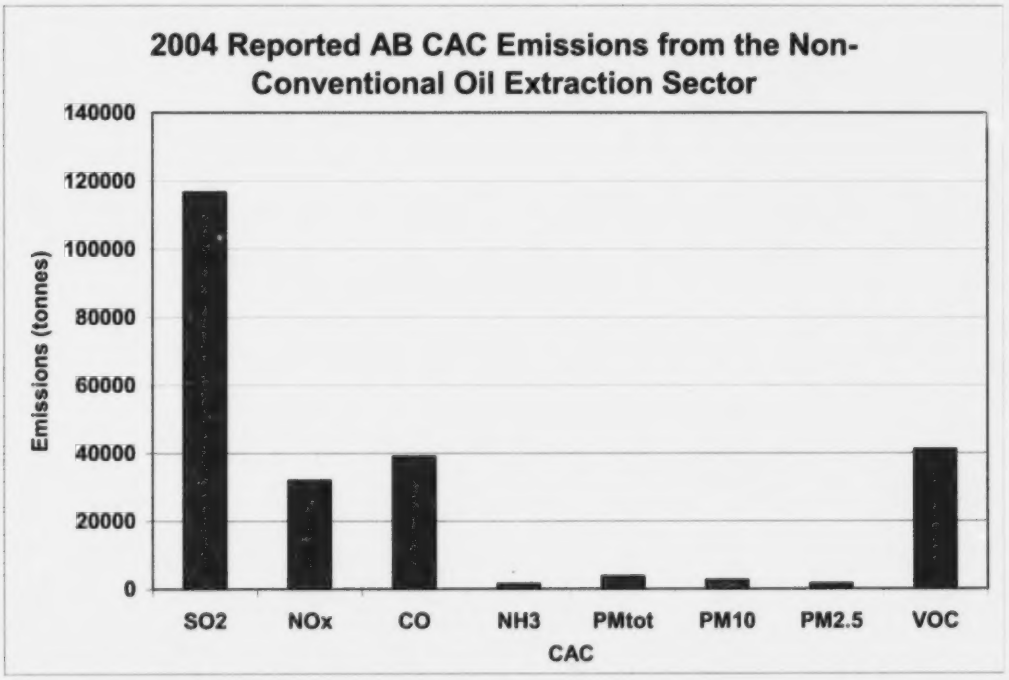

Figure 15: 2004 reported Alberta CAC emissions from the non-conventional oil extraction sector.

4.2.3 Utilities

All seven Criteria Air Contaminants and ammonia (NH_3) were reported by facilities in the utilities sector in 2004. Facilities often reported more than one Criteria Air Contaminant being released. Figure 16 shows the number of Alberta facilities reporting emissions of each CAC in the utilities sector. Emissions of oxides of nitrogen (NOx) were the most common CAC reported by the facilities in the utilities sector. There were 142 facilities that reported NOx emissions, compared with 116 that reported carbon monoxide (CO) emissions. Emissions of particulate matter equal to or smaller than 2.5 micrometres in diameter ($PM_{2.5}$) and emissions of particulate matter equal to or smaller than 10 micrometres in diameter (PM_{10}) were reported by 65 and 52 facilities respectively. There were 17 facilities that reported sulphur dioxide (SO_2) emissions, 16 that reported emissions of volatile organic compounds (VOC), 13 facilities that reported emissions of total particulate matter (PM_{tot}) and eight facilities that reported ammonia emissions.

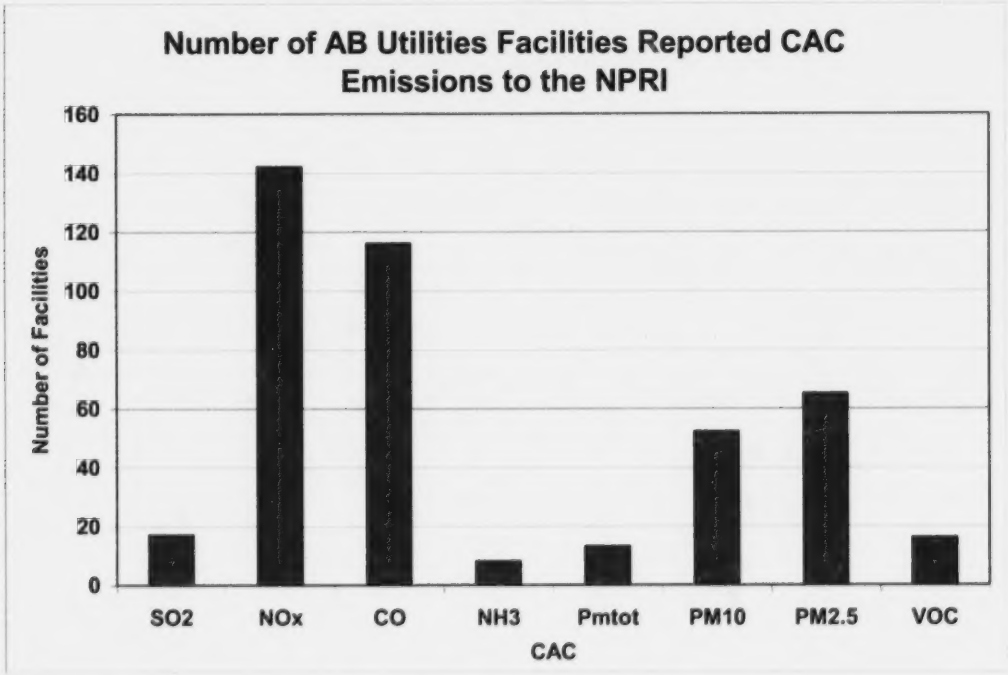

Figure 16: Number of Alberta utilities facilities reporting CAC emissions.

Figure 17 shows the total reported emissions of each CAC from Alberta facilities in the utilities sector. The largest quantity of emissions reported from the utilities sector was SO_2 with 129.1 kt. Six power plants were responsible for 97% of the reported SO_2 emissions in the utilities sector. The second largest quantity of reported emissions was NOx with 95.8 kt and third largest was CO with 24.2 kt. PM_{tot} reported emissions were 9.3 kt, while PM_{10} reported emissions were 6.2 kt. Total reported $PM_{2.5}$ emissions were 3.2 kt, VOC emissions 0.7 kt and NH_3 emissions 0.6 kt.

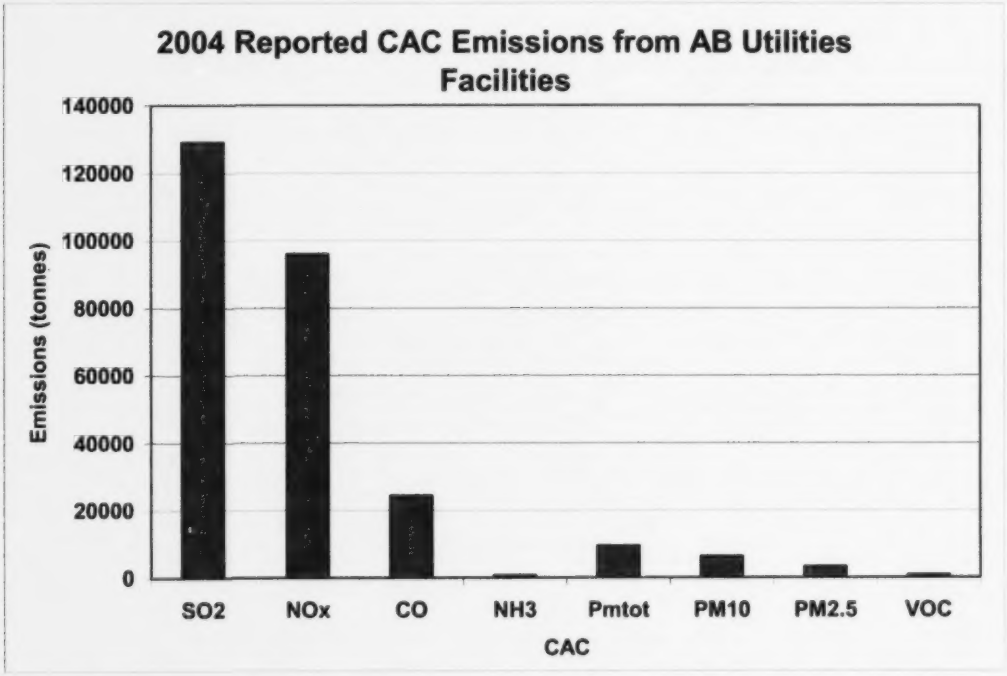

Figure 17: 2004 reported Alberta CAC emissions from the utilities sector.

4.2.4 Manufacturing

All seven Criteria Air Contaminants and ammonia were reported by facilities in the manufacturing sector in 2004. Facilities often reported more than one Criteria Air Contaminant being released. Figure 18 shows the number of Alberta facilities reporting emissions of each CAC in the manufacturing sector. Emissions of particulate matter equal to or smaller than 10 micrometres in diameter (PM_{10}) were the most common CAC reported by facilities in the manufacturing sector. There were 129 facilities that reported PM_{10} emissions, compared to 122 facilities that reported emissions of particulate matter equal to or smaller than 2.5 micrometres in diameter ($PM_{2.5}$). The third largest number of facilities in the manufacturing sector reported emissions of volatile organic compounds (VOC), with 95 facilities reporting. There were 82 facilities that reported emissions of oxides of nitrogen (NOx). There were 76 facilities that reported carbon monoxide (CO) emissions and 76 facilities that reported emissions of total particulate matter (PM_{tot}). Sulphur dioxide (SO_2) emissions were reported by 28 facilities, while 21 facilities reported ammonia emissions.

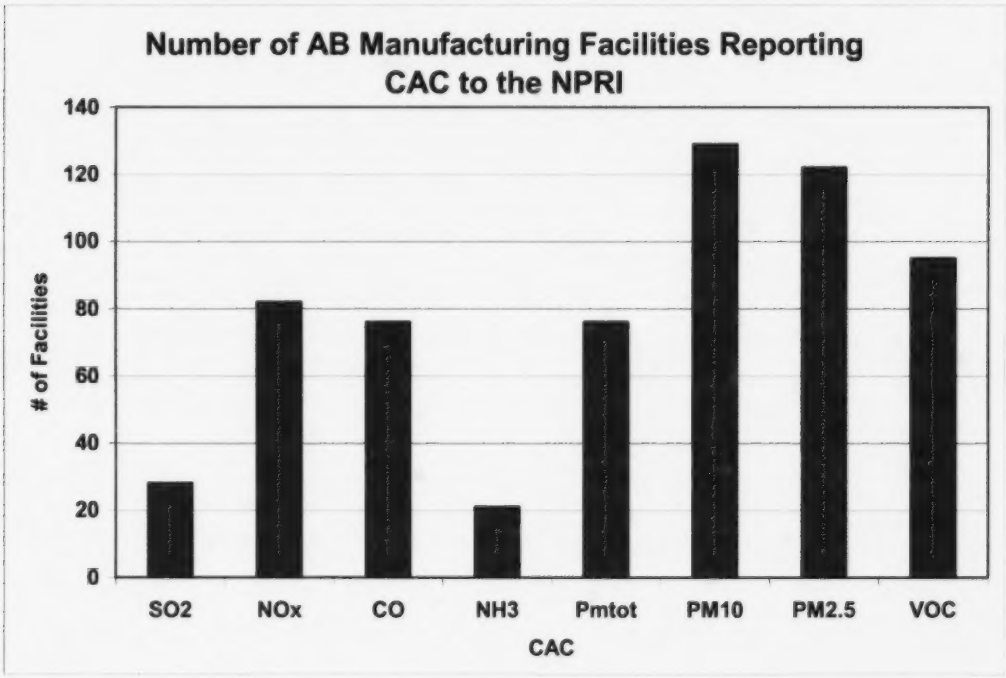

Figure 18: Number of Alberta manufacturing facilities reporting CAC emissions.

Figure 19 shows the total reported emissions of each CAC from Alberta facilities in the manufacturing sector. The largest quantity of reported emissions by manufacturing facilities was CO with 76.5 kt. Reported NOx emissions totaled 32.7 kt and were the second largest quantity of reported emissions released by the manufacturing sector. Total reported VOC emissions totaled 17.3 kt, while SO_2 emissions totaled 16.5 kt. Almost 10 kt of PM_{tot} emissions were reported by manufacturing facilities. Total reported NH_3 emissions from manufacturing facilities were 7.2 kt, for PM_{10} emissions it was 6.0 kt and for $PM_{2.5}$ emissions it was 3.5 kt.

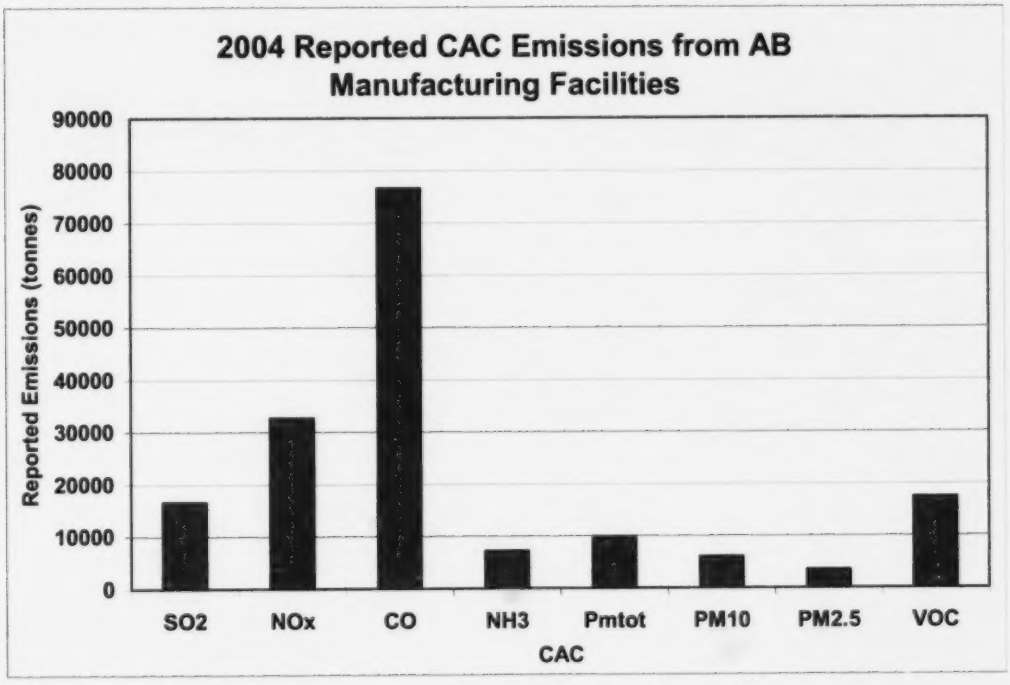

Figure 19: 2004 reported Alberta CAC emissions from the manufacturing sector.

4.3 Comparison to 2003 emissions

Table 3 compares the number of Alberta facilities that reported emissions of criteria air contaminants (CAC) to the NPRI in 2003 and 2004. Caution should be taken when comparing just two years of emissions data, as changes may be partially due to natural fluctuations and reporting variabilities that may have occurred. Longer-term trends for specific substances may show substantially different changes than the change that occurred between 2003 and 2004. Long-term trends are not examined in this report.

There were three fewer facilities that reported sulphur dioxide emissions in 2004 than reported in 2003, which was a one per cent decrease. Between 2003 and 2004, there was an increase of 85 facilities (four per cent) reporting emissions of oxides of nitrogen, an increase of 60 facilities (four per cent) reporting carbon monoxide emissions and an

increase of 53 facilities (14 per cent) reporting emissions of volatile organic compounds. There was an also an increase of 19 facilities (14 per cent) reporting emissions of total particulate matter and an increase of eight facilities (one per cent) reporting emissions of particulate matter equal to or smaller than 10 micrometres in diameter. The number of facilities reporting emissions of particulate matter equal to or smaller than 2.5 micrometres in diameter decreased by 15 or one per cent between 2003 and 2004, while the number of facilities reporting ammonia emissions increased by one or by three per cent.

Table 3: Comparison of the number of Alberta facilities reporting 2003 and 2004 CAC emissions.

CAC	2003 Facilities	2004 Facilities	Change	Per cent Change
SO_2	249	246	-3	-1
NOx	2,158	2,243	85	4
CO	1,427	1,487	60	4
VOC	371	424	53	14
PM_{tot}	137	156	19	14
PM_{10}	1,039	1,047	8	1
$PM_{2.5}$	1,420	1,405	-15	-1
NH_3	34	35	1	3

Table 4 compares the 2003 and 2004 CAC emissions reported to the NPRI by Alberta facilities in all sectors. Total reported 2004 SO_2 emissions from Alberta facilities decreased by 6 kt, or one per cent, of 2003 reported emissions. Total reported NOx emissions increased by 10 kt, or three per cent, between 2003 and 2004. There was also an increase of 36 kt, or 16 per cent, of total reported CO emissions between 2003 and 2004. Total reported VOC emissions decreased by 10 kt, or 11 per cent. Emissions of PM_{tot} decreased by three kt, or 11 per cent, of 2003 levels. There was a two kt, or 10 per cent, decrease in PM_{10} emissions between 2003 and 2004 and a 0.1 kt, or one per cent, decrease in $PM_{2.5}$ emissions. Total reported NH_3 emissions increased by 0.6 kt, or eight per cent, between 2003 and 2004 reporting.

Table 4: Comparison of 2003 and 2004 reported Alberta CAC emissions.

CAC	2003 Emissions (tonnes)	2004 Emissions (tonnes)	Change (tonnes)	Per cent Change
SO_2	409,571	403,495	-6,076	-1
NOx	385,006	395,191	10,185	3
CO	224,071	259,903	35,832	16
VOC	91,902	81,976	-9,926	-11
PM_{tot}	27,914	24,732	-3,182	-11
PM_{10}	19,400	17,458	-1,942	-10
$PM_{2.5}$	10,369	10,234	-135	-1
NH_3	8,584	9,236	652	8

4.4 Provincial comparison

Facilities across Canada that meet set reporting criteria report emissions to the National Pollutant Release Inventory. The quantities and types of emissions that are reported vary greatly by province and territory. This is due to several factors, such as differences in the types of industries present in the jurisdictions. Some jurisdictions may have a large manufacturing industrial base, while others have a large primary or resource-extraction industrial base. Different types of industries have different air emission substances associated with their processes and operations. What industries are found in a given province or territory, will affect the quantity and type of emissions that are reported for that area.

Another factor is the number of industrial facilities that meet the reporting criteria in a jurisdiction. The NPRI only includes facilities that meet the reporting criteria and thresholds. A province or territory that has a large number of facilities reporting will likely have higher emissions for some substances than a province or territory that has fewer facilities. However, the size of the facilities reporting will also impact the overall reported emissions. A very large oil sands facility will likely have much larger reported emissions than a small manufacturing facility for certain substances.

Another factor that impacts the quantities and types of emissions reported to the NPRI is the source of electricity generation. Different sources of electricity used in a province will have different types and quantities of emissions associated with it. For example, coal-fuelled electricity generation will have much higher quantities of sulphur dioxide emissions than hydro, wind or nuclear electricity generation facilities. The emissions reported will also be affected by the location of these facilities. Some provinces and territories generate all their own electricity and may export some to other jurisdictions. Other provinces or territories may require electricity to be imported in from other jurisdictions. The electricity generating facilities will only report their emissions at their site and will not factor in where the electricity associated with their reported emissions is going.

The type and quantity of emissions are also affected by the number of people that live and work in a province or territory. Although the NPRI only includes industrial sources, the number of people in a province or territory will affect the electricity consumed and the industries that are present in that jurisdiction, which will impact the type and quantity of emissions that are reported. The economic conditions of a jurisdiction also affect the quantity of emissions that are reported. A jurisdiction with a growing economy may show increasing emissions due to greater production associated with high demand and new sources reporting as new facilities become operational. Conversely, a jurisdiction with a stagnating or shrinking economy may show decreases in emissions associated with declines in production and fewer sources, as some facilities shutdown.

4.4.1 Sulphur dioxide

Figure 20 shows the number of facilities that reported sulphur dioxide (SO_2) emissions to the NPRI by province and territory. Of the 8,470 facilities that reported at least one air release to the NPRI, 932 of them reported SO_2 emissions. Ontario had the most facilities reporting SO_2 emissions of any province in Canada, with 292 or about 31 per cent of the reporting facilities. Alberta had the second largest number of facilities reporting SO_2 emissions, with 246 or 26 per cent of reporting facilities. Quebec had the third largest number of facilities reporting SO_2, with 136 or 15 per cent of the reporting facilities. The other provinces and territories each had less than 10 per cent of the facilities that reported SO_2 emissions.

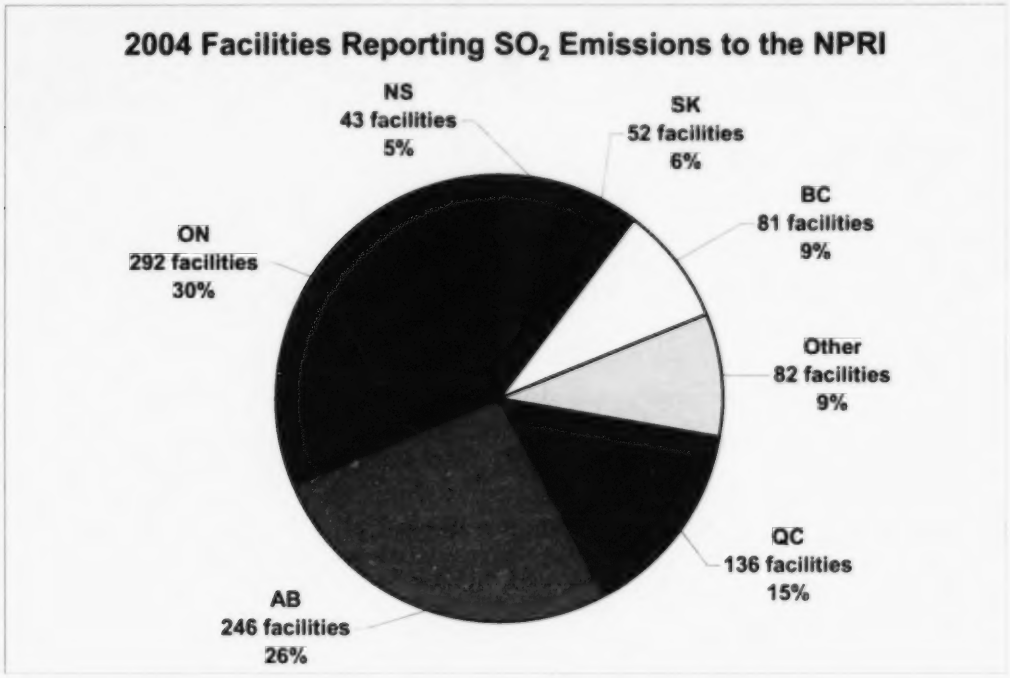

Figure 20: 2004 number of facilities reporting sulphur dioxide emissions.

Figure 21 shows the 2004 SO_2 emissions that were reported to the NPRI by province and territory. A total of 1,944 kt of SO_2 emissions were reported to the NPRI in 2004. Facilities in Ontario were responsible for the largest quantity of reported SO_2 emissions in 2004, with 493 kt or 25 per cent of the national total. Alberta facilities were the second largest emitters of SO_2, with 403 kt or about 21 per cent of the national total. Manitoba facilities were the third largest total emitters, with 379 kt or 20 per cent of the national total. The remaining provinces and territories were each responsible for less than 10 per cent of 2004 SO_2 emissions.

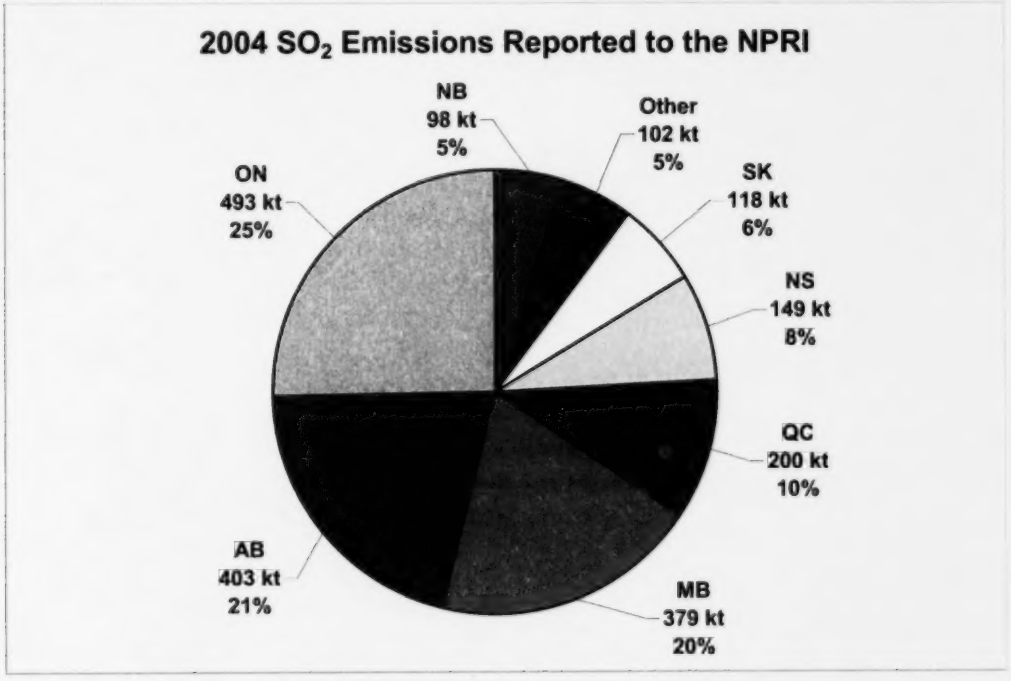

Figure 21: 2004 reported sulphur dioxide emissions.

4.4.2 Oxides of nitrogen

Figure 22 shows the number of facilities that reported emissions of oxides of nitrogen (NOx) to the NPRI by province and territory. Of the 8,470 facilities that reported at least one air release to the NPRI, 3,679 of them reported NOx emissions. Alberta had by far the largest number of facilities reporting NOx emissions in 2004, with 2,243 or 61 per cent of the total reporting facilities. Ontario had the next largest number of facilities reporting NOx emissions, with 432 or abound 12 per cent of the total reporting facilities. British Columbia had the third largest number of facilities reporting NOx emissions, with 418 or 11 per cent of total reporting facilities. The remaining provinces and territories each had fewer than nine per cent of the facilities that reported NOx emissions.

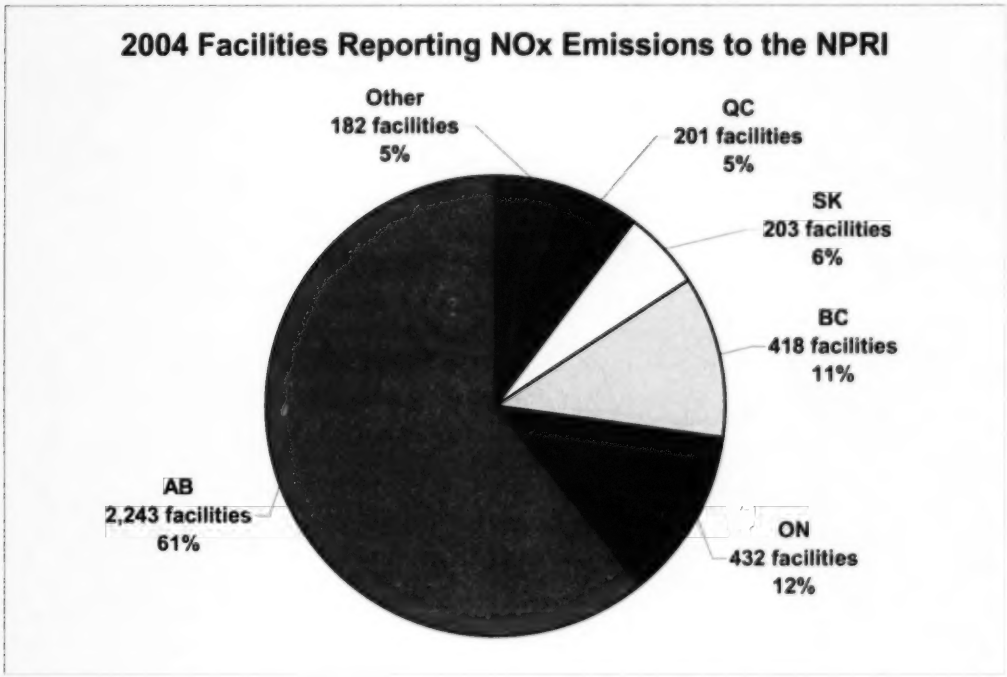

Figure 22: 2004 number of facilities reporting emissions of oxides of nitrogen.

Figure 23 shows the 2004 NOx emissions reported to the NPRI by province and territory. There was a total of 851 kt of NOx emissions reported to the NPRI in 2004. Alberta facilities were responsible for the largest portion of these emissions, with 395 kt or 46 per cent of the reported emissions. Alberta has a large number of oil & gas facilities that are large emitters of NOx. No other province had near the NOx emissions that Alberta did. Ontario facilities were the second largest emitters of NOx emissions, with 141 kt or 17 per cent of reported emissions. The remaining provinces and territories were each responsible for less than 10 per cent of reported NOx emissions.

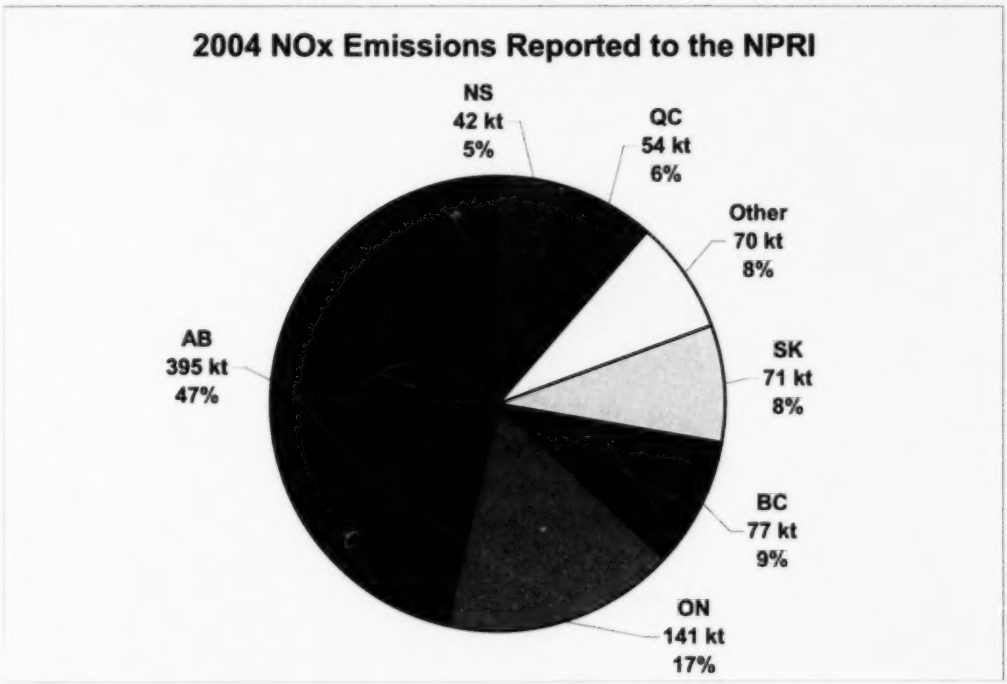

Figure 23: 2004 reported emissions of oxides of nitrogen.

Alberta Environment is actively involved in managing industrial NOx emissions. The *Emissions Management Framework for the Electricity Sector*[xi] is designed to cut NOx emissions from the electricity sector by over 30 per cent by 2025. The Framework contains measures to phase out old technology and provide financial incentives for implementing new technology through the emissions credit system. In September 2006, Alberta Environment participated in the CASA Science Symposium on Nitrogen hosted by the Clean Air Strategic Alliance. The focus of this conference was to increase understanding of the behavior, effects and management of nitrogen emissions.

4.4.3 Carbon monoxide

Figure 24 shows the number of facilities reporting carbon monoxide emissions (CO) to the NPRI by province and territory. Of the 8,470 facilities that reported at least one air release in 2004, 2,731 of them reported CO emissions. Over half of the facilities reporting CO emissions in 2004 were located in Alberta, which had 1,487 facilities reporting (54 per cent). Ontario had the next largest number of facilities reporting CO emissions, with 498 or 18 per cent. British Columbia had the third largest number of facilities reporting CO emissions, with 285 or 10 per cent. The remaining provinces and territories each had fewer 10 per cent of the facilities that reported CO emissions.

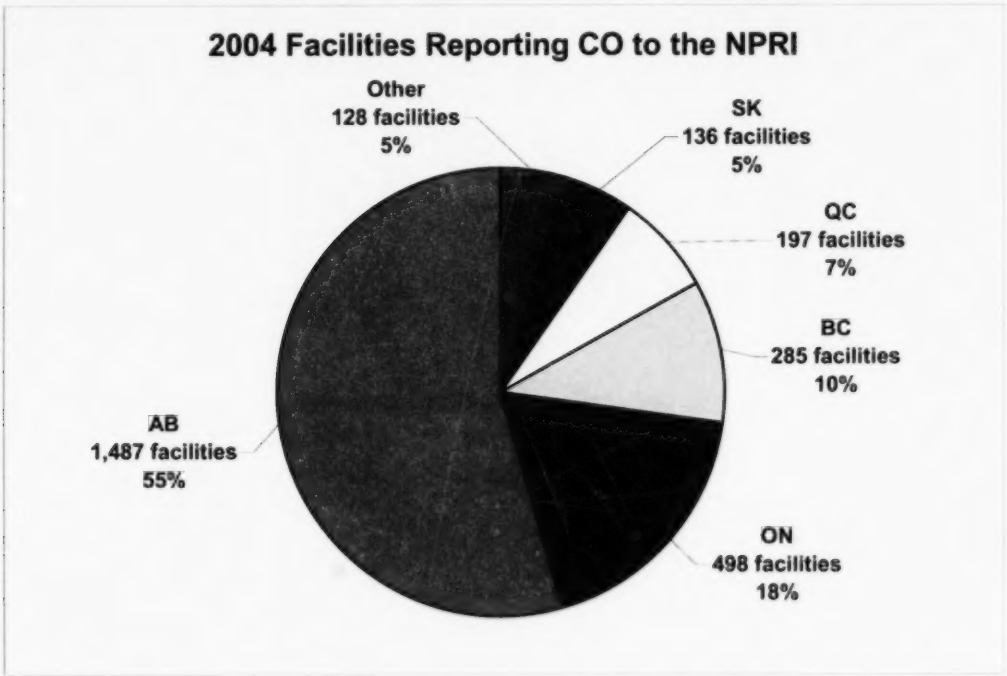

Figure 24: 2004 number of facilities reporting carbon monoxide emissions.

Figure 25 shows the total carbon monoxide emissions reported to the NPRI by province and territory. A total of 1,088 kt of CO emissions were reported to the NPRI in 2004. Facilities in Quebec were responsible for the largest share of the reported CO emissions, with 335 kt or 31 per cent of reported emissions. Alberta facilities were responsible for the second largest portion of the reported CO emissions, with 260 kt or 24 per cent of reported emissions. Facilities in British Columbia and Ontario were the next two largest emitters of reported CO emissions, with 220 kt and 177 kt respectively (20 and 16 per cent of reported emissions). The remaining provinces and territories were each responsible for less than five per cent of reported CO emissions.

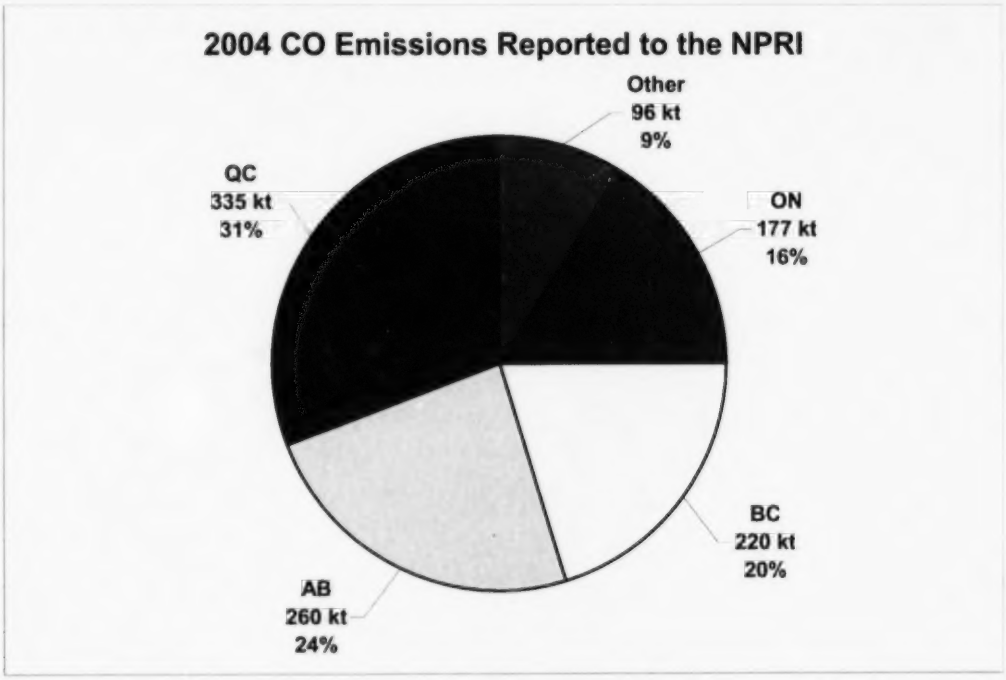

Figure 25: 2004 reported carbon monoxide emissions.

4.4.4 Ammonia

Figure 26 shows the number of facilities that reported ammonia emissions (NH_3) to the NPRI in 2004 by province and territory. Of the 8,470 facilities that reported at least one air emission to the NPRI in 2004, 296 of them reported NH_3 emissions. Ontario had by far the largest number of facilities reporting NH_3 emissions, with 140 or 47 per cent of reporting facilities. Quebec had the second largest number of facilities reporting, with 46 or 16 per cent of reporting facilities. Alberta and British Columbia had the next largest numbers of facilities reporting NH_3 emissions, with 35 and 33 respectively (12 and 11 per cent of reporting facilities). The remaining provinces and territories each had fewer than 10 per cent of the facilities that reported NH_3 emissions.

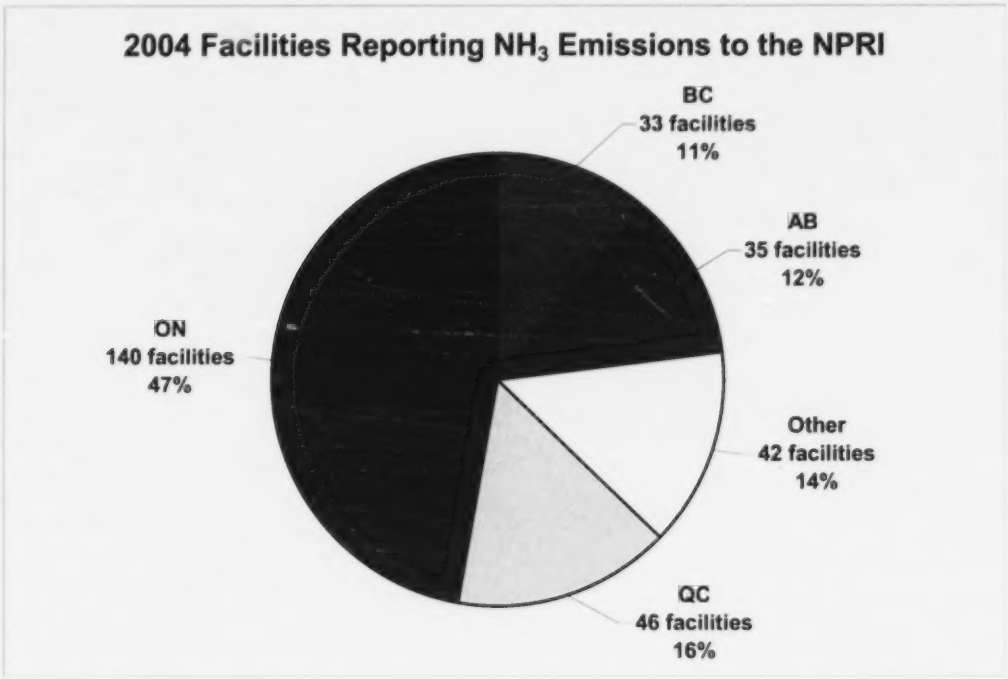

Figure 26: 2004 number of facilities reporting ammonia emissions.

Figure 27 shows the total NH_3 emissions reported to the NPRI by province and territory. A total of 20 kt of NH_3 emissions were reported to the NPRI in 2004. Alberta facilities were responsible for nearly half of the reported emissions, with nine kt or 47 per cent of the reported emissions. Alberta's reported NH_3 emissions were high due mainly to facilities involved in the manufacture of fertilizer. In fact four fertilizer facilities were together responsible for over 70% of reported Alberta NH_3 emissions. Facilities in Ontario were the next largest source of NH_3 emissions, with five kt or 26 per cent of the reported emissions. The remaining provinces and territories were each responsible for less than 10 per cent of the reported NH_3 emissions. Alberta Environment is currently involved in the CASA Confined Feeding Operations Emissions Inventory Subgroup, which is looking into the development of an emissions inventory for several substances that are common to confined feeding operations (including ammonia).

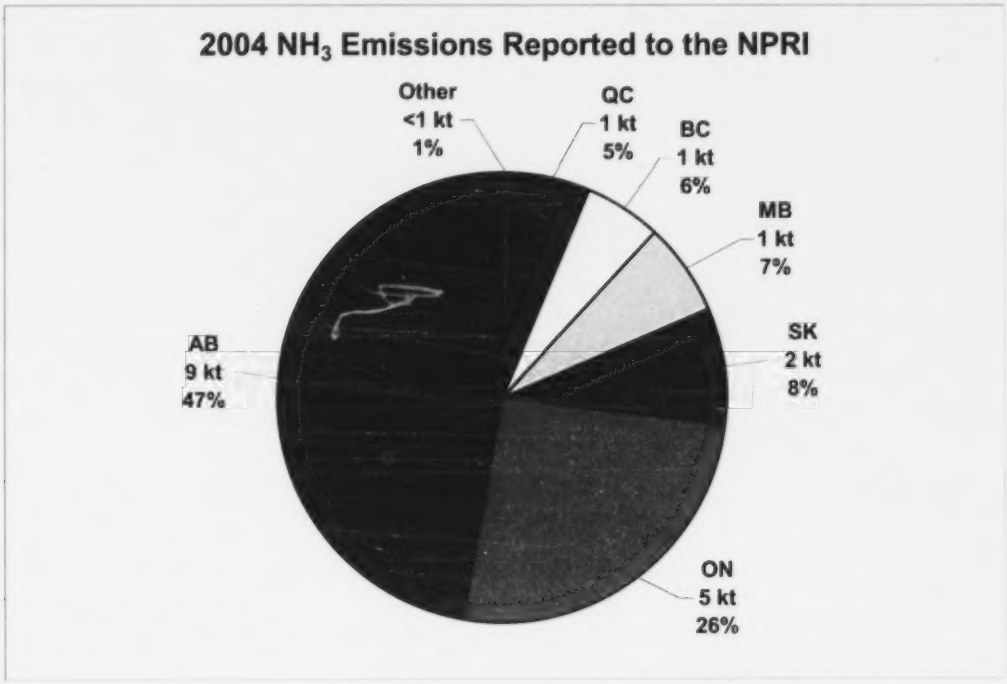

Figure 27: 2004 reported ammonia emissions.

4.4.5 Total particulate matter

Figure 28 shows the number of facilities that reported emissions of total particulate matter (PM_{tot}) to the NPRI by province and territory. Of the 8,470 facilities that reported at least one air emission to the NPRI in 2004, 1,203 of them reported PM_{tot}. Ontario had the largest number of facilities reporting total particulate emissions, with 447 or 37 per cent of total reporting facilities. Quebec had the second largest number of facilities reporting PM_{tot} emissions, with 216 or 18 per cent of the reporting facilities. British Columbia and Alberta had the third and fourth largest numbers of facilities reporting PM_{tot} emissions, with 181 and 156 respectively (15 and 13 per cent of reporting facilities). The remaining provinces and territories each had fewer than 10 per cent of the facilities that reported PM_{tot} emissions.

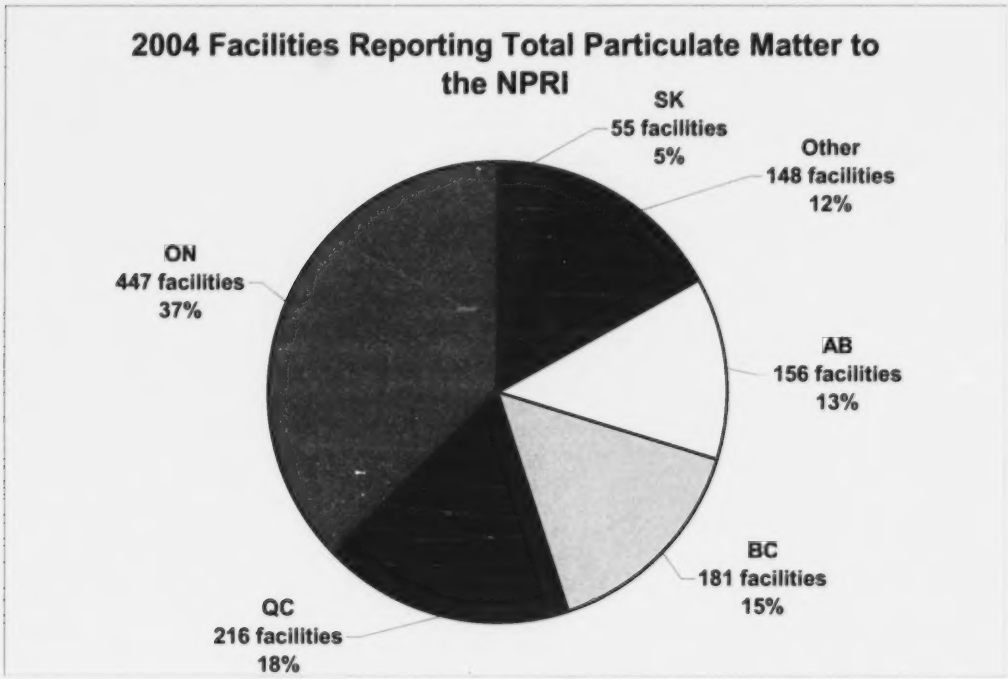

Figure 28: 2004 number of facilities reporting total particulate matter emissions.

Figure 29 shows the total particulate matter emissions that were reported to the NPRI by province and territory. There was a total of 176 kt of total particulate matter emissions reported to the NPRI in 2004. Facilities in Ontario were responsible for the largest portion of reported emissions, with 49 kt or 28 per cent of the reported emissions. Facilities in Quebec and British Columbia were responsible for the next largest portions of reported PM_{tot} emissions with 29 kt and 28 kt respectively (16 per cent of the reported emissions each). Alberta facilities were the source of the next largest amount of PM_{tot} emissions, with 25 kt or 14 per cent of the reported emissions. Facilities in Saskatchewan were the source of the next largest portion of total particulate matter emissions, with 19 kt or 11% of the reported emissions. The remaining provinces and territories were each responsible for five per cent or less of reported PM_{tot} emissions.

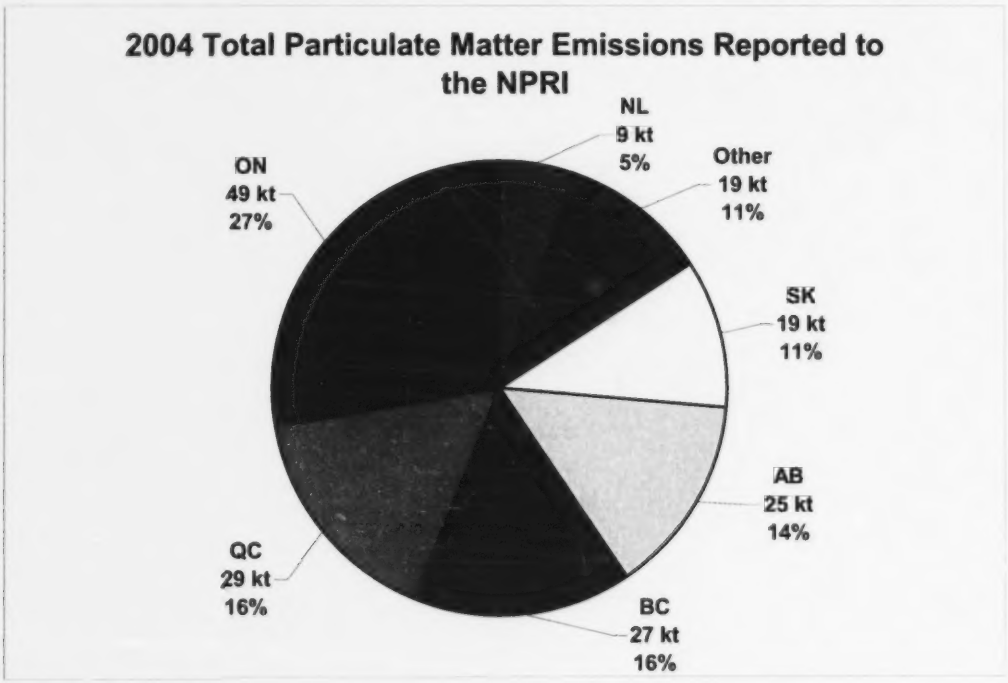

Figure 29: 2004 reported total particulate matter emissions.

4.4.6 Particulate matter equal to or smaller than 10 micrometres in diameter

Figure 30 shows the number of facilities reporting emissions of particulate matter equal to or smaller than 10 micrometres in diameter (PM_{10}) to the NPRI by province and territory. Of the 8,470 facilities that reported at least one air emission to the NPRI in 2004, 3,435 of them reported PM_{10} emissions. Ontario had the largest number of facilities reporting PM_{10} emissions, with 1,100 or 32 per cent of total reporting facilities. Alberta had the second largest number of facilities reporting PM_{10} emissions, with 1,047 or 30 per cent of total reporting facilities. British Columbia and Quebec had the next largest number of facilities reporting PM_{10} emissions, with 413 and 329 respectively (12 and 10 per cent of reporting facilities). The remaining provinces and territories each had fewer than 10 per cent of the facilities that reported PM_{10} emissions.

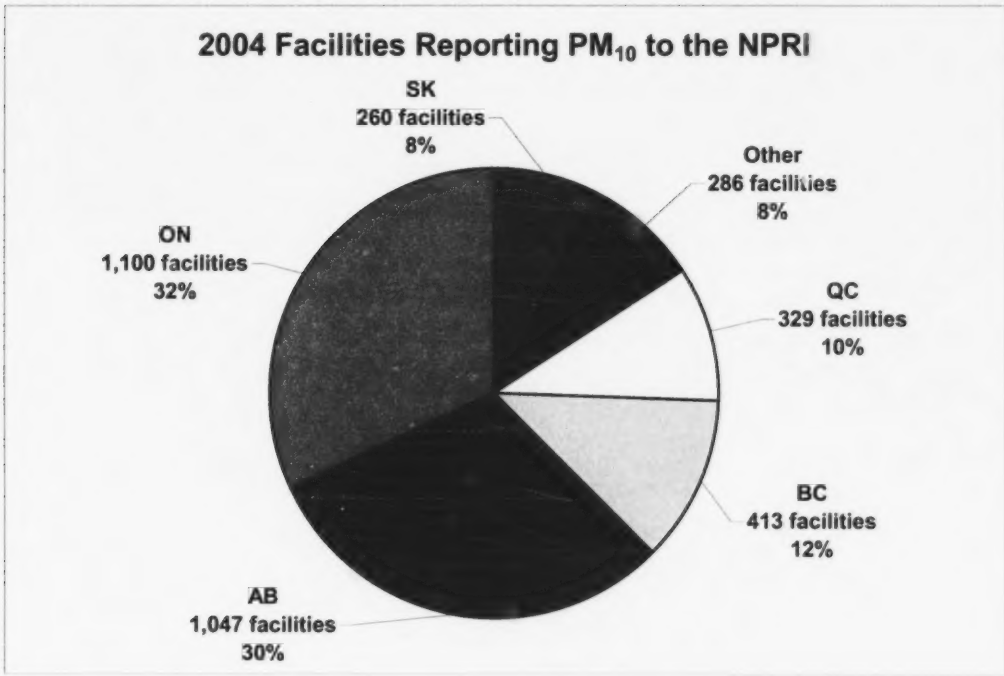

Figure 30: 2004 number of facilities reporting PM_{10} emissions.

Figure 31 shows the total quantity of PM_{10} emissions reported to the NPRI by province and territory. There was a total of 106 kt of PM_{10} emissions reported to the NPRI in 2004. Facilities in Ontario were the largest source of reported PM_{10} emissions, with 34 kt or 33 per cent of total reported emissions. Facilities in Alberta were the second largest source of reported PM_{10} emissions, with 17 kt or 17 per cent or reported emissions. Facilities in Quebec and British Columbia were the next largest emitters of reported PM_{10} emissions with 16 kt and 14 kt respectively (15 and 13 per cent or reported emissions). The remaining provinces and territories each were the source of less than 10 per cent of reported PM_{10} emissions.

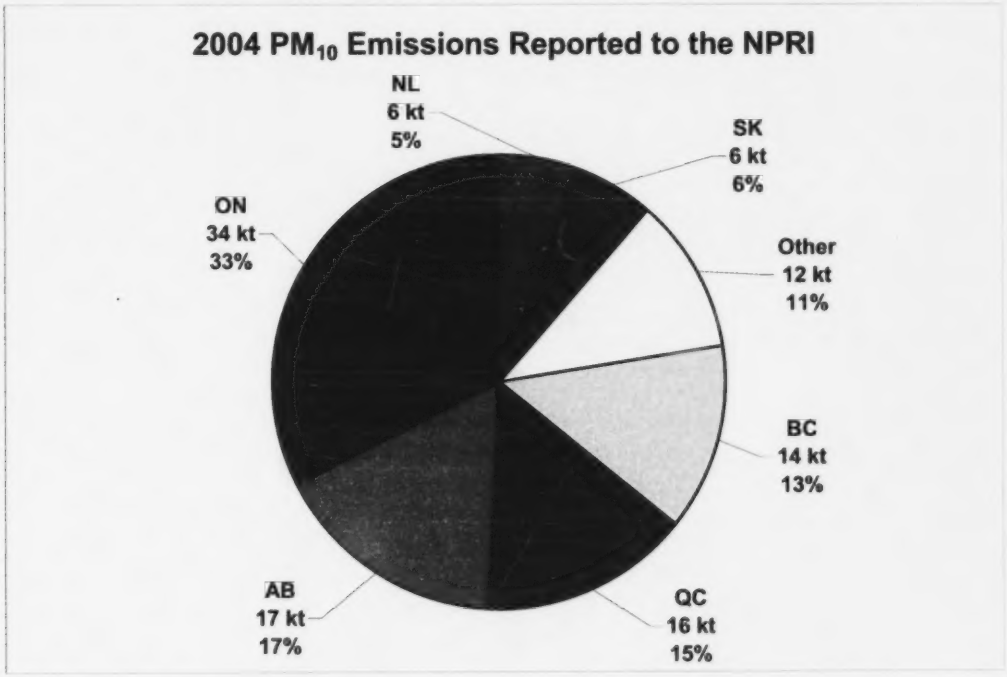

Figure 31: 2004 reported PM_{10} emissions.

4.4.7 Particulate matter equal to or smaller than 2.5 micrometres in diameter

Figure 32 shows the total number of facilities reporting emissions of particulate matter equal to or smaller than 2.5 micrometres in diameter ($PM_{2.5}$) to the NPRI by province and territory. Of the 8,470 facilities that reported at least one air emissions to the NPRI in 2004, 3,753 facilities reported $PM_{2.5}$ emissions. Alberta had the most facilities that reported $PM_{2.5}$ emissions, with 1,405 or 37 per cent of total reporting facilities. Ontario had the second largest number of facilities reporting $PM_{2.5}$ emissions, with 1,036 or 28 per cent of total reporting facilities. British Columbia had the third largest number of facilities reporting $PM_{2.5}$ emissions, with 412 or 11 per cent of total reporting facilities. The remaining provinces and territories each had fewer than 10 per cent of the facilities that reported $PM_{2.5}$ emissions.

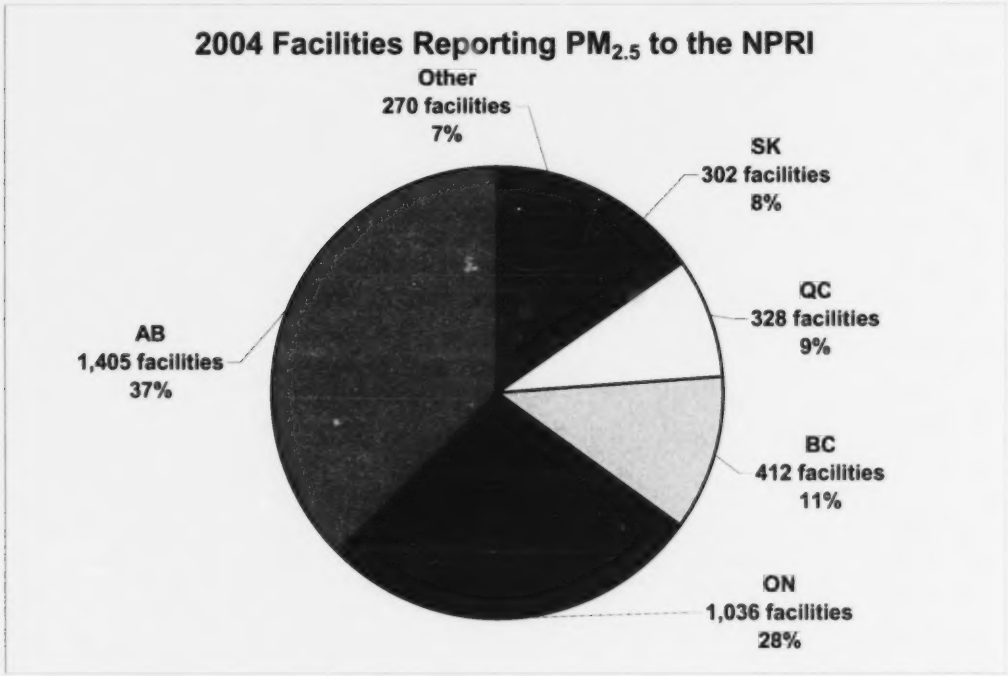

Figure 32: 2004 number of facilities reporting $PM_{2.5}$ emissions.

Figure 33 shows the total quantity of $PM_{2.5}$ emissions reported to the NPRI by province and territory. A total of 63 kt of $PM_{2.5}$ emissions was reported to the NPRI in 2004. Facilities in Ontario were responsible for the largest amount of $PM_{2.5}$ emissions, with 21 kt or 34 per cent of total reported emissions. Facilities in Alberta and Quebec were the next largest sources of reported $PM_{2.5}$ emissions, with 10 kt each or 16 per cent of total reported emissions. Facilities in British Columbia were responsible for the next largest quantity of reported $PM_{2.5}$ emissions, with eight kt or 14 per cent of total reported emissions. The remaining provinces and territories were each responsible for five per cent or less of total reported $PM_{2.5}$ emissions.

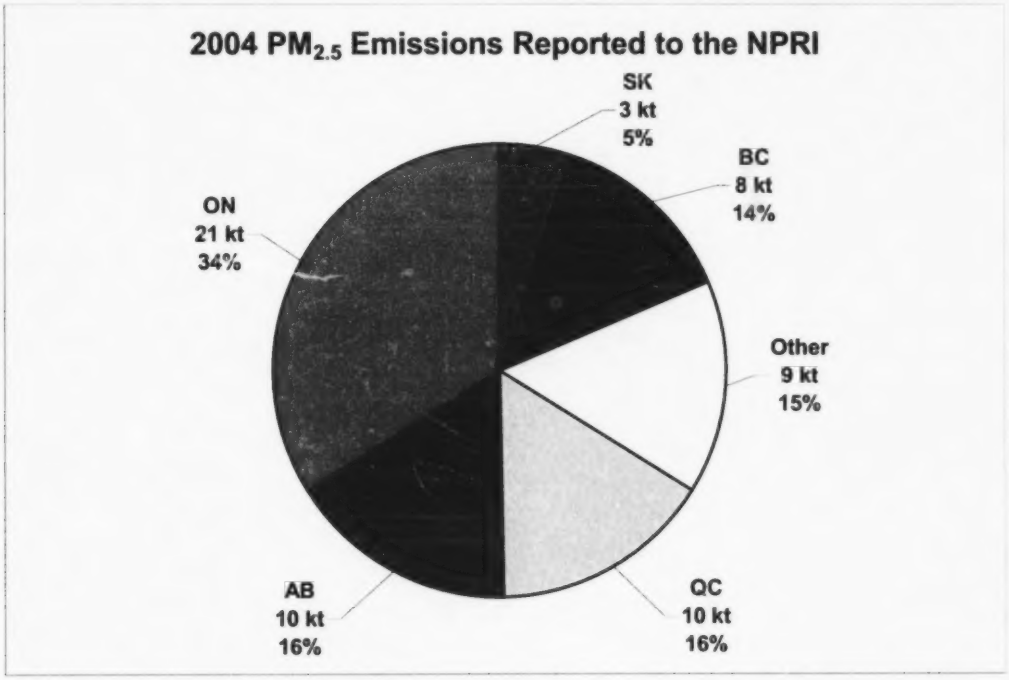

Figure 33: 2004 reported $PM_{2.5}$ emissions.

4.4.8 Volatile organic compounds

Figure 34 shows the total number of facilities reporting emissions of volatile organic compounds (VOC) to the NPRI by province and territory. Of the 8,470 facilities that reported at least one air emission to the NPRI in 2004, 2,108 of them reported VOC emissions. Ontario had the most facilities reporting VOC emissions, with 813 or 39 per cent of total reporting facilities. Alberta had the second largest number of facilities reporting VOC emissions, with 424 or 20 per cent of total reporting facilities. Quebec and British Columbia had third and forth largest number of facilities reporting VOC emissions, with 341 and 275 respectively (16 and 13 per cent of reporting facilities). The remaining provinces and territories each had fewer than 10 per cent of the facilities that reported VOC emissions.

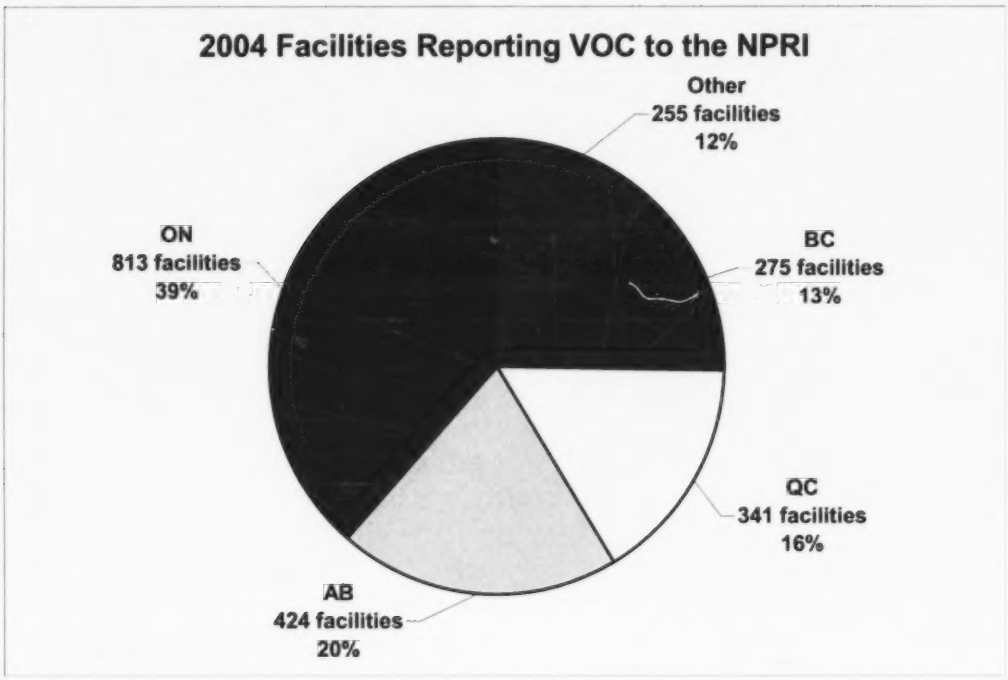

Figure 34: 2004 number of facilities reporting volatile organic compound emissions.

Figure 35 shows the total quantity of emissions of volatile organic compounds that were reported to the NPRI by province and territory. There was a total of 268 kt of VOC emissions reported to the NPRI in 2004. Facilities in Alberta were responsible for nearly a third of total reported VOC emissions, with 82 kt or 31 per cent of total reported emissions. Facilities in Ontario were the source of the second largest quantity of reported VOC emissions, with 78 kt or 29 per cent of total reported emissions. Facilities in Quebec and British Columbia were each responsible for the next largest portion of reported VOC emissions, with 33 kt and 30 kt (12 and 11 per cent of reported emissions). The remaining provinces and territories were each responsible for five per cent or less of total reported VOC emissions.

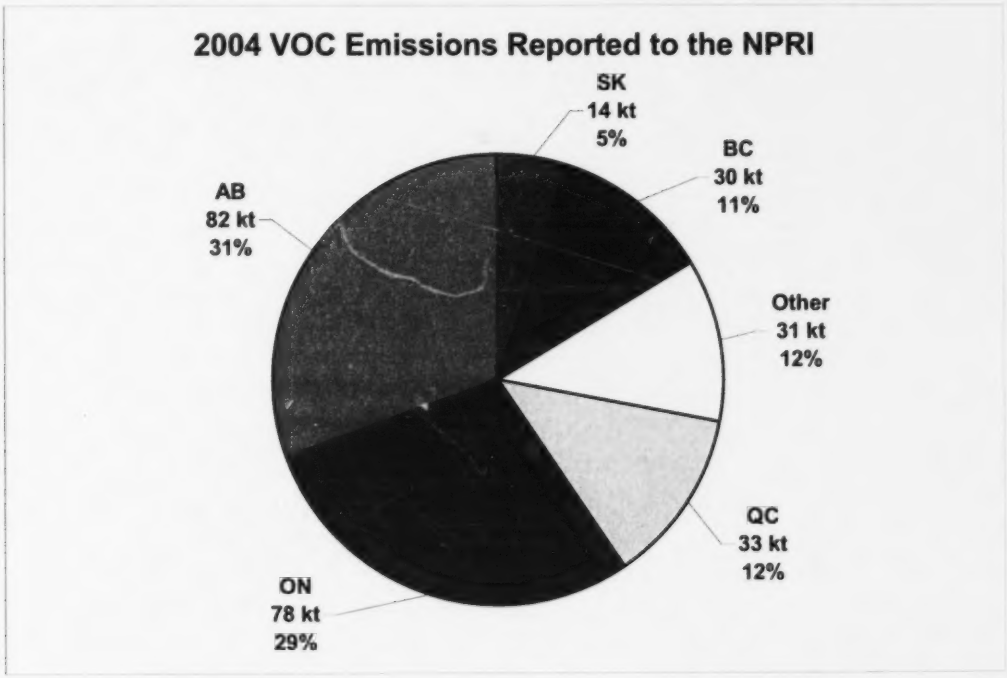

Figure 35: 2004 reported volatile organic compound emissions.

4.5 Comparison with the 2002 National CAC Inventory

Criteria Air Contaminant emissions data that is reported to the NPRI is used in the development of the National Criteria Air Contaminant Inventory[vii] (CAC Inventory). The NPRI is the major provider of industrial point source emissions data used in the CAC Inventory. As NPRI reporting is restricted to industrial facilities that meet set reporting criteria, the CAC Inventory also utilizes data provided by other agencies, such as Provincial Governments and Statistics Canada.

The amount of total CAC emissions accounted for by NPRI reporting varies by each CAC substance and by province/territory. The 2004 NPRI reported emissions were compared to the 2002 National Criteria Air Contaminant Inventory. The 2002 CAC Inventory was used for the comparison because it is the most current publicly available National CAC Inventory. Section 4.5.1 examines the amount of Alberta CAC emissions accounted for by NPRI reporting. Section 4.5.2 examines the amount of total Canadian CAC emissions accounted for by NPRI reporting. Table 11 summarizes the total CAC emissions for Alberta and Canada that were published in the 2002 National CAC Inventory. Tables 12-17 show the breakdown of the 2002 CAC Inventory emissions by source category. The CAC Inventory includes emissions from both point and area industrial and non-industrial sources. The CAC Inventory also uses different sector categories than those used in NPRI reporting (which uses the North American Industry Classification System).

4.5.1 Comparison of NPRI Alberta CAC emissions with the 2002 National Criteria Air Contaminant Inventory

The comparison of the 2004 Alberta reported NPRI criteria air contaminant (CAC) emissions to the 2002 National Criteria Air Contaminant Inventory[vii] (CAC Inventory), excluding open sources, is summarized in Table 5. Coverage is less than 100 per cent for all CAC substances since the CAC Inventory includes both point and area industrial and non-industrial sources, while the NPRI only includes industrial point sources that meet set reporting criteria. Differences between the reported NPRI and the CAC Inventory emissions also occurred because the comparison used two different years of emissions data (2002 and 2004).

Total 2004 reported Alberta sulphur dioxide (SO_2) emissions accounted for 80 per cent of the Alberta SO_2 emissions (excluding open sources) in the 2002 CAC Inventory. Total 2004 reported Alberta emissions of oxides of nitrogen (NOx) accounted for 52 per cent of the Alberta NOx emissions (excluding open sources) in the 2002 CAC Inventory. Total 2004 reported Alberta carbon monoxide (CO) emissions accounted for 14 per cent of the Alberta CO emissions (excluding open sources) in the 2002 CAC Inventory. Total 2004 reported Alberta ammonia (NH_3) emissions accounted for 13 per cent of the Alberta NH_3 emissions (excluding open sources) in the 2002 CAC Inventory.

Total 2004 reported Alberta total particulate matter (PM_{tot}) emissions accounted for 24 per cent of the Alberta PM_{tot} emissions (excluding open sources) in the 2002 CAC Inventory. Total 2004 reported Alberta emissions of particulate matter equal to or smaller than 10 micrometres in diameter (PM_{10}) accounted for 25 per cent of the Alberta PM_{10} emissions (excluding open sources) in the 2002 CAC Inventory. Total 2004 reported Alberta emissions of particulate matter equal to or smaller than 2.5 micrometers in diameter ($PM_{2.5}$) accounted for 21 per cent of the Alberta $PM_{2.5}$ emissions (excluding open sources) in the 2002 CAC Inventory. Total 2004 reported Alberta emissions of volatile organic compounds (VOC) accounted for 15 per cent of the Alberta VOC emissions (excluding open sources) in the 2002 CAC Inventory.

Table 5: Comparison of the 2004 NPRI Alberta CAC emissions and the 2002 National CAC Inventory Alberta emissions (excluding open sources).

CAC	2004 NPRI (tonnes)	2002 CAC (tonnes)	Difference (tonnes)	% Coverage
Sulphur dioxide	403,495	501,793	-98,298	80
Oxides of nitrogen	395,191	758,102	-362,911	52
Carbon monoxide	259,903	1,864,821	-1,604,918	14
Ammonia	9,236	70,867	-61,631	13
Total particulate matter	24,732	104,283	-79,551	24
Particulate matter < 10 micrometres in diameter	17,458	68,526	-51,068	25
Particulate matter < 2.5 micrometres in diameter	10,234	48,869	-38,635	21
Volatile organic compounds	81,976	536,108	-454,132	15

The comparison of the 2004 CAC emissions reported to the NPRI by Alberta facilities to the 2002 CAC Inventory, including open sources, is summarized in Table 6. Including open sources (agriculture, construction, forest fires, etc), the coverage of total reported Alberta NPRI CAC emissions for each CAC substances in the CAC Inventory decreased. The decrease occurred because the only open sources reported to the NPRI are from construction operations and landfill sites.

Total 2004 reported Alberta SO_2 emissions accounted for 80 per cent of the Alberta SO_2 emissions (including open sources) in the 2002 CAC Inventory. Total 2004 reported Alberta NOx emissions accounted for 51 per cent of the Alberta NOx emissions (including open sources) in the 2002 CAC Inventory. Total 2004 reported Alberta CO emissions accounted for 10 per cent of the Alberta CO emissions (including open sources) in the 2002 CAC Inventory. Total 2004 reported Alberta NH_3 accounted for six per cent of the Alberta NH_3 emissions (including open sources) in the 2002 CAC Inventory.

Total 2004 reported Alberta PM_{tot} emissions accounted for less than one per cent of the Alberta PM_{tot} emissions (including open sources) in the 2002 CAC Inventory. Total 2004 reported Alberta PM_{10} emissions accounted for one per cent of the Alberta PM_{10} emissions (including open sources) in the 2002 CAC Inventory. Total 2004 reported Alberta $PM_{2.5}$ emissions accounted for three per cent of the Alberta $PM_{2.5}$ emissions

(including open sources) in the 2002 CAC Inventory. Total 2004 reported Alberta VOC emissions accounted for 11 per cent of the Alberta VOC emissions (including open sources) in the 2002 CAC Inventory.

Table 6: Comparison of the 2004 NPRI Alberta CAC emissions and the 2002 National CAC Inventory Alberta emissions (including open sources).

CAC	2004 NPRI (tonnes)	2002 CAC (tonnes)	Difference (tonnes)	% Coverage
Sulphur dioxide	403,495	501,855	-98,360	80
Oxides of nitrogen	395,191	780,671	-385,480	51
Carbon monoxide	259,903	2,571,090	-2,311,187	10
Ammonia	9,236	150,430	-141,194	6
Total particulate matter	24,732	5,682,471	-5,657,739	<1
Particulate matter < 10 micrometres in diameter	17,458	1,911,393	-1,893,935	1
Particulate matter < 2.5 micrometres in diameter	10,234	367,575	-357,341	3
Volatile organic compounds	81,976	745,657	-663,681	11

4.5.2 Comparison of NPRI CAC emissions with the 2002 National Criteria Air Contaminant Inventory.

The comparison of the 2004 reported NPRI criteria air contaminant (CAC) emissions to the 2002 National Criteria Air Contaminant Inventory[vii] (CAC Inventory), excluding open sources, is summarized in Table 7. Coverage is less than 100 per cent for all CAC substances since the CAC Inventory includes both point and area industrial and non-industrial sources, while the NPRI only includes industrial point sources that meet set reporting criteria. Differences between the reported NPRI and the CAC Inventory emissions also occurred because the comparison used two different years of emissions data (2002 and 2004).

Total 2004 reported sulphur dioxide (SO_2) emissions accounted for 86 per cent of the SO_2 emissions (excluding open sources) in the 2002 CAC Inventory. Total 2004 reported emissions of oxides of nitrogen (NOx) accounted for 34 per cent of the NOx emissions (excluding open sources) in the 2002 CAC Inventory. Total 2004 reported carbon monoxide (CO) emissions accounted for 10 per cent of the CO emissions (excluding open sources) in the 2002 CAC Inventory. Total 2004 reported ammonia (NH_3) emissions accounted for 8 per cent of the NH_3 emissions (excluding open sources) in the 2002 CAC Inventory.

Total 2004 reported total particulate matter (PM_{tot}) emissions accounted for 19 per cent of the PM_{tot} emissions (excluding open sources) in the 2002 CAC Inventory. Total 2004 reported emissions of particulate matter equal to or smaller than 10 micrometres in diameter (PM_{10}) accounted for 19 per cent of the PM_{10} emissions (excluding open sources) in the 2002 CAC Inventory. Total 2004 reported emissions of particulate matter equal to or smaller than 2.5 micrometers in diameter ($PM_{2.5}$) accounted for 16 per cent of

the $PM_{2.5}$ emissions (excluding open sources) in the 2002 CAC Inventory. Total 2004 reported emissions of volatile organic compounds (VOC) accounted for 12 per cent of the VOC emissions (excluding open sources) in the 2002 CAC Inventory.

Table 7: Comparison of the 2004 NPRI CAC emissions and the 2002 National CAC Inventory emissions (excluding open sources).

CAC	2004 NPRI (tonnes)	2002 CAC (tonnes)	Difference (tonnes)	% Coverage
Sulphur dioxide	1,943,619	2,267,450	-323,831	86
Oxides of nitrogen	850,755	2,468,720	-1,617,965	34
Carbon monoxide	1,087,983	10,826,804	-9,738,821	10
Ammonia	19,508	256,025	-236,517	8
Total particulate matter	175,709	944,243	-768,534	19
Particulate matter < 10 micrometres in diameter	105,537	552,419	-446,882	19
Particulate matter < 2.5 micrometres in diameter	62,654	391,058	-328,404	16
Volatile organic compounds	268,171	2,149,116	-1,880,945	12

The comparison of the 2004 reported NPRI CAC emissions to the 2002 CAC Inventory (including open sources) for Alberta is summarized in Table 8. Including open sources (agriculture, construction, forest fires, etc) the coverage of NPRI reported emissions for each CAC substance in the CAC Inventory decreased. The decrease occurred because the only open sources reported to the NPRI are from construction operations and landfill sites.

Total 2004 reported SO_2 emissions accounted for 86 per cent of the SO_2 emissions (including open sources) in the 2002 CAC Inventory. Total 2004 reported NOx emissions accounted for 33 per cent of the NOx emissions (including open sources) in the 2002 CAC Inventory. Total 2004 reported CO emissions accounted for eight per cent of the CO emissions (including open sources) in the 2002 CAC Inventory. Total 2004 reported NH_3 emissions accounted for three per cent of the NH_3 emissions (including open sources) in the 2002 CAC Inventory.

Total 2004 reported PM_{tot} emissions accounted for one per cent of the PM_{tot} emissions (including open sources) in the 2002 CAC Inventory. Total 2004 reported PM_{10} emissions accounted for two per cent of the PM_{10} emissions (including open sources) in the 2002 CAC Inventory. Total 2004 reported $PM_{2.5}$ emissions accounted for five per cent of the $PM_{2.5}$ emissions (including open sources) in the 2002 CAC Inventory. Total 2004 reported VOC emissions accounted for nine per cent of the VOC emissions (including open sources) in the 2002 CAC Inventory.

Table 8: Comparison of the 2004 NPRI CAC emissions and the 2002 National CAC Inventory emissions (including open sources).

CAC	2004 NPRI (tonnes)	2002 CAC (tonnes)	Difference (tonnes)	% Coverage
Sulphur dioxide	1,943,619	2,268,213	-324,594	86
Oxides of nitrogen	850,755	2,574,106	-1,723,351	33
Carbon monoxide	1,087,983	14,148,243	-13,060,260	8
Ammonia	19,508	573,813	-554,305	3
Total particulate matter	175,709	15,999,877	-15,824,168	1
Particulate matter < 10 micrometres in diameter	105,537	5,523,355	-5,417,818	2
Particulate matter < 2.5 micrometres in diameter	62,654	1,346,241	-1,283,587	5
Volatile organic compounds	268,171	2,875,468	-2,607,297	9

Glossary

Air emissions inventory: An air emissions inventory is an accounting of pollutant emissions released to the air over a given time and for a given political or geographic region.

Airshed management zone: Airshed management zones are locally driven, multi-stakeholder, consensus-based organizations that seek to improve air quality by addressing local issues and by implementing air quality monitoring systems. They are independent organizations that are endorsed by the Clean Air Strategic Alliance Board.

Ambient air quality: Ambient air quality is a measure of the substances dispersed in the air and is used to indicate the state of the air.

Ammonia: Ammonia (NH_3) is a colourless gas with a pungent odour. Major sources of ammonia emissions include the fertilizer industry and commercial feedlots. Although ammonia is not specifically listed as a Criteria Air Contaminant in the NPRI, it is included with the seven Criteria Air Contaminants substances in this report to be consistent with the CAC inventories.

Carbon disulphide: Pure carbon disulphide is a colorless liquid with a pleasant odour that smells sweet. The impure form of carbon disulfide is usually used in most industrial processes and it is a yellowish liquid with an unpleasant odour. Carbon disulfide evaporates at room temperature. Carbon disulphide is produced and used in the various manufacturing operations and can be emitted from oil refineries, timber processing facilities, gas plants and oil sands operations.

Carbon monoxide: Carbon monoxide (CO) is a colourless, odourless, poisonous gas that is formed during the incomplete combustion of fossil fuels. Other sources beside combustion of fossil fuels include various industrial processes.

Clean Air Strategic Alliance: The Clean Air Strategic Alliance (CASA) was established in March 1994 to help Alberta Environment manage air quality issues in Alberta. CASA is a non-profit association and a multi-stakeholder partnership that is composed of representatives from government, industry and non-government organizations and works using a consensus-based model.

Conventional oil and gas extraction: The conventional oil and gas extraction sector (NAICS 211113) is a Canadian specific NAICS code that is a subset of NAICS 21 - mining and oil and gas extraction. This sector comprises facilities that extract naturally occurring materials, specifically crude petroleum and gases (such as natural gas), using conventional extraction methods. Facilities in this sector include gas plants, refineries, etc.

Criteria Air Contaminant: Criteria Air Contaminants (CAC) are air pollutants that are commonly released into the air by various sources. The NPRI identifies seven substances as CACs including: carbon monoxide, oxides of nitrogen, total particulate matter, particulate matter less than or equal to 10 micrometres in diameter, particulate matter less than or equal to 2.5 micrometres in diameter, sulphur dioxide and volatile organic compounds. Although not specifically identified as a CAC substance, ammonia is included with the seven CAC substances in the analysis used in this report.

Emissions: Emissions are a quantity of a substance that is released to the air from a source.

Fair air quality: Air quality is considered fair in Alberta when the air quality index is rated as 25-50. Air quality in this range means that there is adequate protection against harmful effects to soil, water, vegetation, animals, materials, visibility and human health from the air quality index pollutants in the air.

Good air quality: Air quality is considered good in Alberta when the air quality index is rated as 25 or lower. Air quality in this range means that the concentrations of air quality index pollutants in the air have no known harmful effects to soil, water, vegetation, animals, materials, visibility or human health.

Greenhouse gases: Greenhouse gases are any gas that absorbs infrared radiation in the Earth's atmosphere. Greenhouse gases can come from both natural and human activities. Common greenhouse gases that result from human activities include carbon dioxide, methane and nitrous oxide. Greenhouse gases are not reported to the NPRI, but are reported to the Alberta Specified Gas Reporting Program and the National Mandatory Greenhouse Gas Reporting Program.

Manufacturing: The manufacturing sector is made up of facilities involved in the mechanical, physical, or chemical transformation of materials, substances, or components into new products. The assembling of component parts of manufactured products is considered manufacturing, except in cases where the activity is appropriately classified in NAICS 23, construction. Facilities in the manufacturing sector include various types of plants, factories and mills.

Methanol: Methanol is a colourless liquid, which can mix completely with water and organic solvents. It has an agreeable odour and a burning taste. It is used in various industrial processes and manufacturing operations.

National Criteria Contaminant Inventory: The National Criteria Contaminant Inventory is compiled by the Pollution Data Division of Environment Canada and provides emission data for eight CAC substances by province/territory and for all of Canada. The most recent CAC Inventory available is for 2002. More information on the National CAC Inventory is available at: http://www.ec.gc.ca/pdb/cac/cac_home_e.cfm.

National Pollutant Release Inventory: The National Pollutant Release Inventory (NPRI) is the largest national publicly available industrial emissions inventory in Canada. It is administered by the Pollution Data Division of Environment Canada and is mandated under the authority of the *Canadian Environmental Protection Act, 1999*[xvi] (CEPA). Facilities that meet certain reporting criteria and whose emissions meet or exceed the set reporting thresholds of NPRI-listed substances are required to report. More information on NPRI reporting is available at: http://www.ec.gc.ca/pdb/npri/npri_home_e.cfm.

Nitric oxide: Nitric oxide is one of the oxides of nitrogen. It is a colourless and odourless gas. At high temperatures, fossil fuel combustion can combine with oxygen to form nitric oxide. Sources of nitric oxide include transportation, oil and gas industries and power plants.

Nitrogen dioxide: Nitrogen dioxide (NO_2) is one of the oxides of nitrogen (NOx) and is a reddish-brown gas with a pungent odour that is a precursor to the formation of ozone and subsequently smog. Major sources include transportation, oil and gas facilities and power plants.

Non-conventional oil extraction: The non-conventional oil and gas extraction sector (NAICS 211114) is a Canadian specific NAICS code that is a subset of NAICS 21 – mining and oil and gas extraction. This sector comprises facilities that extract naturally occurring materials, specifically crude petroleum using non-conventional extraction methods. Facilities in this sector include oil sands and heavy oil facilities.

Non-Criteria Air Contaminants: Non-Criteria Air Contaminants (Non-CAC) are all the substances released to the air that are reported to the NPRI, and are not identified as one of the seven Criteria Air Contaminants or ammonia.

North American Industry Classification System: The North American Industry Classification System (NAICS) is a standardized classification system for industrial facilities and activities. NAICS codes are two, four and six-digit codes that classify a facility according to set sector codes. The two-digit codes are very broad, four-digit more specific and six-digit very specific. The system allows groupings of similar types of facilities across North America, however, there are some differences in the six-digit NAICS codes used in Canada and the United States.

Oil and gas extraction: The oil and gas extraction sector is made up facilities involved in the extraction and production of oil, gas and hydrocarbon liquids through various processes. The oil and gas extraction sector includes both facilities involved in conventional oil and gas extraction and non-conventional oil extraction.

One Window to National Environmental Reporting System: The One Window to National Environmental Reporting System (OWNERS) is an on-line reporting mechanism used by various government agencies and industrial organizations to collect environmental data from primarily industrial facilities. More information on OWNERS is available at: http://www.owners.gc.ca/home_e.html.

Oxides of nitrogen: Oxides of nitrogen (NO_x) are the total of nitrogen dioxide (NO_2) and nitric oxide (NO). NOx is formed when nitrogen and oxygen combine at high temperatures. The combustion of fossil fuels and various industrial processes can produce NOx. NOx is a precursor to the formation of ozone, which can cause declines in air quality. NOx emissions can also be a contributor to acid rain.

Ozone: Ozone is a colourless, odourless gas that is not emitted directly by human activities. Ozone in the lower atmosphere is instead created through complex chemical reactions involving oxides of nitrogen and volatile organic compounds with sunlight. Ozone can also be transported to the ground from the upper atmosphere by natural weather processes. It is a principle component of urban smog and can lead to poor air quality incidents.

Particulate matter: Particulate matter is solid particles that are found in the air. Particulate matter may be released directly into the atmosphere or formed in the atmosphere as a result of physical or chemical transformations of precursors. Particulate matter is formed in various industrial processes. Some common sources of particulate matter include combustion of fossil fuels, industrial separation processes, land treatment, storage piles and mine tailings. Particulate matter in the atmosphere can reduce visibility and form smog. Some particulate matter can be inhaled and may cause respiratory problems.

Particulate matter less than or equal to 10 micrometres in diameter: Particulate matter less than or equal to 10 micrometres in diameter (PM_{10}) is any particulate matter that has a diameter of less than or equal to 10 microns.

Particulate matter less than or equal to 2.5 micrometres in diameter: Particulate matter less than or equal to 2.5 micrometres in diameter ($PM_{2.5}$) is any particulate matter that has a diameter of less than or equal to 2.5 microns.

Poor air quality: Air quality is considered poor in Alberta when the air quality index is rated as 51-100. Air quality in this range means not all aspects of human health or the environment are adequately protected from possible adverse effects from the concentrations of air quality index pollutants in the air.

Total particulate matter: Total particulate matter (PM_{tot}) is any particulate matter with a diameter smaller than or equal to 100 micrometres.

Sulphur dioxide: Sulphur dioxide (SO_2) is a colourless gas with a pungent odour and is formed when sulphur is oxidized and emitted to the atmosphere. SO_2 is emitted when fuels that contain sulphur (such as coal and oil) are burned. SO_2 is also emitted during various other industrial processes. SO_2 is a precursor to the formation of particulate matter and, subsequently, smog. SO_2 emissions can also be a contributor to acid rain.

Sulphuric acid: Sulphuric acid is a colourless viscous corrosive liquid, and is used in various industrial processes including the manufacture of fertilizer, oil refining and material processing.

Utilities: The utilities sector is made up of facilities that provide electric power (generation, transmission, and distribution), natural gas (distribution), steam (provision and/or distribution), water (treatment and distribution) and sewage removal (collection, treatment, and disposal of waste through sewer systems and sewage treatment facilities).

Very poor air quality: Air quality is considered very poor in Alberta when the air quality index is rated as 100 or greater. Air quality in this range means the concentrations of air quality index pollutants in the air are at intolerable level and continued exposure to very poor air quality could pose a risk to public health.

Volatile organic compound: Volatile organic compounds (VOCs) are an aggregate grouping of about 1,000 organic substances that readily dissipate. Some VOCs can undergo photochemical reactions in the atmosphere and contribute to the formation of particulate matter and ozone, which can lead to a decline in air quality. There are many sources of VOCs, such as loading and unloading of petroleum products, petroleum spills, process venting, spill remediation, flaring of untreated natural gas, evaporative losses from storage tanks, painting and stripping activities, degreasing activities, burning fuel and the use of solvents and wood preservatives.

NAICS Code Descriptions

The following definitions of NAICS codes are from Statistics Canada's *North American Industry Classification System (NAICS) 2002 – Canada* [xx].

Oil and Gas Extraction (NAICS 2111)
This industry group comprises establishments primarily engaged in operating oil and gas field properties. Such activities may include exploration for crude petroleum and natural gas; drilling, completing and equipping wells; operating separators, emulsion breakers, desilting equipment and field gathering lines for crude petroleum; and all other activities in the preparation of oil and gas up to the point of shipment from the producing property. This industry includes the production of oil, the mining and extraction of oil from oil shale and oil sands, and the production of gas and hydrocarbon liquids, through gasification, liquefaction and pyrolysis of coal at the mine site.

Canadian NAICS codes also include several unique subcategories for mining and oil and gas extraction. Two used in the 2004 NPRI emissions analysis are:

Conventional Oil and Gas Extraction (NAICS 211113)
This Canadian industry comprises establishments primarily engaged in the exploration for, and/or production of, petroleum or natural gas from wells in which the hydrocarbons will initially flow or can be produced using normal pumping techniques.

Exclusion(s): Establishments primarily engaged in:
producing crude oil from surface shales or tar sands or from reservoirs in which the hydrocarbons are semisolids and conventional production methods are not possible (211114, Non-Conventional Oil Extraction) performing oil field services for operators, on a contract or fee basis (213118, Services to Oil and Gas Extraction) recovering liquefied petroleum gases incidental to petroleum refining (324110, Petroleum Refineries).

Non-Conventional Oil Extraction (NAICS 211114)
This Canadian industry comprises establishments primarily engaged in producing crude oil from surface shales or tar sands or from reservoirs in which the hydrocarbons are semisolids and conventional production methods are not possible.

Exclusion(s): Establishments primarily engaged in:
the exploration for, and/or production of, petroleum or natural gas from wells in which the hydrocarbons will initially flow or can be produced using normal pumping techniques (211113, Conventional Oil and Gas Extraction) performing oil field services for operators, on a contract or fee basis (213118, Services to Oil and Gas Extraction) recovering liquefied petroleum gases incidental to petroleum refining (324110, Petroleum Refineries).

Utilities (NAICS 22)
This sector comprises establishments primarily engaged in operating electric, gas and water utilities. These establishments generate, transmit, control and distribute electric

power; distribute natural gas; treat and distribute water; operate sewer systems and sewage treatment facilities; and provide related services, generally through a permanent infrastructure of lines, pipes and treatment and processing facilities.

Manufacturing (NAICS 31-33)
This sector comprises establishments primarily engaged in the physical or chemical transformation of materials or substances into new products. These products may be finished, in the sense that they are ready to be used or consumed, or semi-finished, in the sense of becoming a raw material for an establishment to use in further manufacturing. Related activities, such as the assembly of the component parts of manufactured goods; the blending of materials; and the finishing of manufactured products by dyeing, heat-treating, plating and similar operations are also treated as manufacturing activities. Manufacturing establishments are known by a variety of trade designations, such as plants, factories or mills.

Manufacturing establishments may own the materials which they transform or they may transform materials owned by other establishments. Manufacturing may take place in factories or in workers' homes, using either machinery or hand tools.

Certain activities involving the transformation of goods are classified in other sectors. Some examples are post-harvest activities of agricultural establishments, such as crop drying; logging; the beneficiating of mineral ores; the production of structures by construction establishments; and various activities conducted by retailers, such as meat cutting and the assembly of products such as bicycles and computers.

Wholesale Trade (NAICS 41)
This sector comprises establishments primarily engaged in wholesaling merchandise and providing related logistics, marketing and support services. The wholesaling process is generally an intermediate step in the distribution of merchandise; many wholesalers are therefore organized to sell merchandise in large quantities to retailers, and business and institutional clients. However, some wholesalers, in particular those that supply non-consumer capital goods, sell merchandise in single units to final users.

This sector recognizes two main types of wholesalers, that is, wholesale merchants and wholesale agents and brokers.

Wholesale Merchants

Wholesale merchants buy and sell merchandise on their own account, that is, they take title to the goods they sell. They generally operate from warehouse or office locations and they may ship from their own inventory or arrange for the shipment of goods directly from the supplier to the client. In addition to the sale of goods, they may provide, or arrange for the provision of, logistics, marketing and support services, such as packaging and labelling, inventory management, shipping, handling of warranty claims, in-store or co-op promotions, and product training. Dealers of machinery and equipment, such as dealers of farm machinery and heavy-duty trucks, also fall within this category.

Wholesale merchants are known by a variety of trade designations depending on their

relationship with suppliers or customers, or the distribution method they employ. Examples include wholesale merchants, wholesale distributors, drop shippers, rack-jobbers, import-export merchants, buying groups, dealer-owned cooperatives and banner wholesalers.

The first eight subsectors of wholesale trade comprise wholesale merchants. The grouping of these establishments into industry groups and industries is based on the merchandise line or lines supplied by the wholesaler.

Wholesale Agents and Brokers

Wholesale agents and brokers buy and sell merchandise owned by others on a fee or commission basis. They do not take title to the goods they buy or sell, and they generally operate at or from an office location.

Wholesale agents and brokers are known by a variety of trade designations including import-export agents, wholesale commission agents, wholesale brokers, and manufacturer's representatives and agents.

Transportation and Warehousing (NAICS 48-49)
This sector comprises establishments primarily engaged in transporting passengers and goods, warehousing and storing goods, and providing services to these establishments. The modes of transportation are road (trucking, transit and ground passenger), rail, water, air and pipeline. These are further subdivided according to the way in which businesses in each mode organize their establishments. National post office and courier establishments, which also transport goods, are included in this sector. Warehousing and storage establishments are subdivided according to the type of service and facility that is operated.

Many of the establishments in this sector are structured as networks, with activities, workers, and physical facilities distributed over an extensive geographic area.

Exclusion(s): Establishments primarily engaged in:
renting and leasing transportation equipment without operator (532, Rental and Leasing Services)

Table 9: 2004 NPRI Alberta CAC air emissions.

CAC	# of Facilities Reporting this CAC	Total Reported Emissions of this CAC (tonnes)
Sulphur dioxide	246	403,495
Oxides of nitrogen	2,243	395,191
Carbon monoxide	1,487	259,903
Ammonia	35	9,236
Total particulate matter	156	24,732
Particulate matter < 10 micrometres in diameter	1,047	17,458
Particulate matter < 2.5 micrometres in diameter	1,405	10,234
Volatile organic compounds	424	81,976

Table 10: 2004 NPRI Alberta non-CAC air emissions.

Substance	Facilities Reporting	Total Reported Emissions of the Substance (tonnes)
Acetaldehyde	13	205.640
Acetonitrile	1	6.891
Acetophenone	1	0.100
Acrolein	4	71.132
Anthracene	3	0.151
Arsenic (and its compounds)	13	0.474
Benzene	90	253.392
Benzo(a)anthracene	9	0.050
Benzo(a)phenanthrene	7	0.034
Benzo(a)pyrene	9	0.016
Benzo(b)fluoranthene	10	0.006
Benzo(e)pyrene	12	0.014
Benzo(g,h,i)perylene	11	0.009
Benzo(j)fluoranthene	8	0.003
Benzo(k)fluoranthene	10	0.003
Biphenyl	2	0.335
Butadiene:1,3-	3	12.806
Butoxyethanol:2-	4	80.694
Butyl alcohol:i-	4	24.419
Butyl alcohol:n-	2	79.146
Cadmium (and its compounds)	22	0.263
Calcium fluoride	1	2.901
Carbon disulphide	24	2,712.176
Carbon tetrachloride	1	0.018
Carbonyl sulphide	21	1,541.151
Chlorine	6	17.000
Chlorine dioxide	2	11.906
Chloroethane	2	0.320
Chloroform	2	0.127

Substance	Facilities Reporting	Total Reported Emissions of the Substance (tonnes)
Chromium (and its compounds)	8	7.018
Cobalt (and its compounds)	6	0.462
Copper (and its compounds)	6	1.759
Cresol (mixed isomers and their salts)	1	0.097
Cumene	4	13.193
Cyclohexane	73	366.475
Dibenz(a,j)acridine	5	0.001
Dibenzo(a,h)anthracene	9	0.001
Dibenzo(a,i)pyrene	3	0.001
Dibenzo(c,g)carbazole:7H-	2	<0.001
Dichloroethane:1,2-	2	7.683
Dichloromethane	5	38.415
Dicyclopentadiene	2	3.218
Diethanolamine (and its salts)	7	11.321
Dioxane:1,4-	1	0.350
Dioxins and furans	19	<0.001
Ethylbenzene	53	183.098
Ethylene	20	1,101.260
Ethylene glycol	24	158.950
Ethylene oxide	3	9.082
Fluoranthene	12	0.449
Formaldehyde	29	328.508
Formic acid	2	0.446
HCFC-142b	1	111.134
HCFC-22	5	1.687
Hexachlorobenzene	17	0.005
Hexachloroethane	1	0.001
Hexane:n-	116	1,738.924
Hexavalent chromium compounds	11	1.826
Hydrochloric acid	21	461.738
Hydrogen fluoride	9	1,217.511
Hydrogen sulphide	80	1,636.226
Indeno(1,2,3-CD)pyrene	11	0.005
Isoprene	1	0.136
Isopropyl alcohol	9	82.519
Lead (and its compounds)	24	1.403
Manganese (and its compounds)	15	12.408
Mercury (and its compounds)	27	1.063
Methanol	72	2,531.786
Methyl ethyl ketone	7	77.198
Methyl isobutyl ketone	3	31.208
Methyl-2-pyrrolidone:N-	1	0.100
Methylenebis(phenylisocyanate)	3	0.112

Substance	Facilities Reporting	Total Reported Emissions of the Substance (tonnes)
Molybdenum trioxide	1	1.301
Naphthalene	11	13.566
Nickel (and its compounds)	11	4.311
Nitrate ion in solution at pH >= 6.0	1	16.420
Nitric acid	1	0.044
PAHs, total Schedule 1, Part 2	4	0.466
Pentachloroethane	1	0.001
Perylene	10	0.002
Phenanthrene	11	3.510
Phenol (and its salts)	4	8.964
Phenylenediamine (and its salts):p-	1	0.004
Phosphorus (total)	9	88.666
Polymeric diphenylmethane diisocyanate	3	4.492
Propylene	18	244.287
Pyrene	11	0.432
Selenium (and its compounds)	1	0.002
Styrene	9	172.251
Sulphuric acid	19	1,928.691
Tetrachloroethane:1,1,2,2-	1	0.022
Tetrachloroethylene	3	0.396
Tetraethyl lead	1	<0.001
Titanium tetrachloride	1	0.025
Toluene	110	756.324
Toluenediisocyanate (mixed isomers)	2	0.130
Trichloroethane:1,1,2-	1	0.134
Trichloroethylene	1	14.100
Trimethylbenzene:1,2,4-	45	159.756
Vanadium (except when in an alloy) and its compounds	6	5.043
Vinyl acetate	1	114.000
Vinyl chloride	2	8.523
Xylene (all isomers)	120	1,293.278
Zinc (and its compounds)	13	12.232

Table 11: 2002 total CAC emissions for Alberta and Canada.

A) Alberta*

Category / Sector	SO_2 (tonnes)	NOx (tonnes)	CO (tonnes)	NH_3 (tonnes)	PM_{tot} (tonnes)	PM_{10} (tonnes)	$PM_{2.5}$ (tonnes)	VOC (tonnes)
Total Industrial Sources	362,139	429,756	593,542	8,217	69,632	41,067	26,066	395,168
Total Non Industrial Fuel Combustion Sources	132,827	98,527	39,976	361	16,863	11,374	8,791	6,622
Total Transportation Sources	6,437	225,836	1,229,276	2,084	13,108	12,981	11,988	92,035
Total Incineration Sources	381	3,981	566	596	239	161	158	456
Total Miscellaneous Sources	8	2	1,461	59,609	4,441	2,942	1,866	41,827
Total Open Sources	62	22,569	706,268	79,563	5,578,188	1,842,868	318,707	209,548
Total With Open Sources	501,855	780,671	2,571,090	150,430	5,682,471	1,911,393	367,575	745,657
Total Without Open Sources	501,793	758,102	1,864,821	70,867	104,283	68,526	48,869	536,108

B) Canada*

Category / Sector	SO_2 (tonnes)	NOx (tonnes)	CO (tonnes)	NH_3 (tonnes)	PM_{tot} (tonnes)	PM_{10} (tonnes)	$PM_{2.5}$ (tonnes)	VOC (tonnes)
Total Industrial Sources	1,536,648	743,696	1,740,891	32,790	636,219	307,526	175,644	795,377
Total Non Industrial Fuel Combustion Sources	654,447	359,800	782,940	4,908	201,852	147,263	130,066	167,398
Total Transportation Sources	74,546	1,357,753	8,279,432	18,634	75,460	74,400	67,583	692,383
Total Incineration Sources	1,726	7,386	11,063	3,299	2,390	2,016	1,907	3,379
Total Miscellaneous Sources	84	85	12,478	196,394	28,322	21,215	15,858	490,578
Total Open Sources	763	105,386	3,321,438	317,788	15,055,634	4,970,936	955,183	726,353
Total With Open Sources	2,268,213	2,574,106	14,148,243	573,813	15,999,877	5,523,355	1,346,241	2,875,468
Total Without Open Sources	2,267,450	2,468,720	10,826,804	256,025	944,243	552,419	391,058	2,149,116

*Adapted from the 2002 National CAC Inventory[vii], numbers may not add up due to rounding.

Table 12: 2002 CAC emissions from industrial sources for Alberta and Canada.

A) Alberta*

Category / Sector	SO_2 (tonnes)	NOx (tonnes)	CO (tonnes)	NH_3 (tonnes)	PM_{tot} (tonnes)	PM_{10} (tonnes)	$PM_{2.5}$ (tonnes)	VOC (tonnes)
Abrasives Manufacture	0	0	0	0	0	0	0	0
Aluminum Industry	3,802	194	0	0	97	0	0	0
Asbestos Industry	0	0	0	0	0	0	0	0
Asphalt Paving Industry	0	0	34	0	2,125	300	110	0
Bakeries	0	0	0	0	0	0	0	289
Cement and Concrete Industry	1,640	4,402	1,662	0	2,867	1,428	475	36
Chemicals Industry	3,183	17,030	3,515	6,081	2,518	1,819	1,137	1,797
Clay Products Industry	17	12	25	0	608	39	3	0
Coal Mining Industry	1,285	1,099	0	0	3,163	1,756	1,065	491
Ferrous Foundries	0	2	797	0	87	82	76	5
Grain Industries	0	0	0	0	12,245	2,643	479	0
Iron and Steel Industries	41	179	266	0	165	89	67	57
Iron Ore Mining Industry	0	0	0	0	0	0	0	0
Mining and Rock Quarrying	0	0	0	0	219	18	2	139
Non-Ferrous Mining and Smelting	0	0	0	173	22	22	2	0
Oil Sands	103,772	21,114	39,435	1,243	4,233	3,022	1,840	34,313
Other Petroleum and Coal Products	0	0	0	0	0	0	0	0
Paint & Varnish Manufacturing	0	0	0	0	0	0	0	10
Petrochemical Industry	131	5,676	1,933	0	282	277	123	3,551
Petroleum Refining	7,100	4,373	4,932	20	919	688	454	1,699
Plastics & Synthetic Resins Fabrication	0	21	0	0	8	8	5	103
Pulp and Paper Industry	3,244	4,547	8,413	305	1,716	1,194	924	1,715
Upstream Oil and Gas Industry	237,791	358,852	350,973	0	5,453	5,438	5,427	338,574
Wood Industry	57	3,453	170,798	78	19,104	11,108	5,280	7,417
Other Industries	76	8,804	10,760	318	13,802	11,139	8,599	4,970
Total Industrial Sources	362,139	429,756	593,542	8,217	69,632	41,067	26,066	395,168

*Adapted from the 2002 National CAC Inventory[xii], numbers may not add up due to rounding.

B) Canada*

Category / Sector	SO_2 (tonnes)	NOx (tonnes)	CO (tonnes)	NH_3 (tonnes)	PM_{tot} (tonnes)	PM_{10} (tonnes)	$PM_{2.5}$ (tonnes)	VOC (tonnes)
Abrasives Manufacture	9	11	2	9	244	86	76	58
Aluminum Industry	62,729	1,968	332,007	265	10,729	6,759	5,069	1,479
Asbestos Industry	404	117	42	2	53	37	14	1
Asphalt Paving Industry	68	139	1,177	52	32,981	4,939	1,673	963
Bakeries	0	1	2	1	0	0	0	5,625
Cement and Concrete Industry	47,787	42,860	22,372	374	25,126	12,844	5,114	858
Chemicals Industry	16,765	27,607	13,458	9,726	4,779	3,238	1,912	5,930
Clay Products Industry	340	89	221	42	11,977	1,215	424	5
Coal Mining Industry	2,313	2,830	42	0	13,834	7,323	3,561	1,537
Ferrous Foundries	1,337	427	48,426	31	6,661	5,940	5,308	793
Grain Industries	0	1	1	0	61,589	13,426	2,396	0
Iron and Steel Industries	32,093	18,907	43,529	225	18,779	10,781	6,954	17,867
Iron Ore Mining Industry	12,513	7,002	6,656	136	47,839	28,282	13,467	1,176
Mining and Rock Quarrying	3,198	13,534	11,043	909	109,582	15,944	6,502	1,046
Non-Ferrous Mining and Smelting	762,096	4,726	4,298	313	11,487	8,111	5,910	72
Oil Sands	108,022	23,562	41,011	1,243	4,358	3,147	1,965	35,784
Other Petroleum and Coal Products	397	90	285	10	7	7	6	625
Paint & Varnish Manufacturing	0	27	4	19	73	71	62	2,593
Petrochemical Industry	155	6,660	3,149	50	513	466	164	6,110
Petroleum Refining	106,313	32,052	74,718	127	6,663	5,034	3,400	18,314
Plastics & Synthetic Resins Fabrication	55	275	2,181	111	260	242	180	4,423
Pulp and Paper Industry	71,202	53,396	130,000	4,436	39,906	28,164	20,632	24,764
Upstream Oil and Gas Industry	277,914	431,238	423,380	6,197	9,061	9,040	8,962	533,133
Wood Industry	2,959	15,350	544,983	4,635	136,853	77,211	36,210	58,050
Other Industries	27,978	60,824	37,905	3,878	82,813	65,218	45,681	74,173
Total Industrial Sources	1,536,648	743,696	1,740,891	32,790	636,219	307,526	175,644	795,377

*Adapted from the 2002 National CAC Inventory[VII], numbers may not add up due to rounding.

Table 13: 2002 CAC emissions from non-industrial fuel combustion sources for Alberta and Canada.

A) Alberta*

Category / Sector	SO_2 (tonnes)	NOx (tonnes)	CO (tonnes)	NH_3 (tonnes)	PM_{tot} (tonnes)	PM_{10} (tonnes)	$PM_{2.5}$ (tonnes)	VOC (tonnes)
Commercial Fuel Combustion	653	4,506	904	25	563	545	527	243
Electric Power Generation (Utilities)	131,925	86,732	10,674	263	10,912	5,796	3,283	939
Residential Fuel Combustion	194	6,907	3,018	39	1,058	911	871	548
Residential Fuel Wood Combustion	54	381	25,380	34	4,331	4,122	4,109	4,892
Total Non Industrial Fuel Combustion Sources	132,827	98,527	39,976	361	16,863	11,374	8,791	6,622

B) Canada*

Category / Sector	SO_2 (tonnes)	NOx (tonnes)	CO (tonnes)	NH_3 (tonnes)	PM_{tot} (tonnes)	PM_{10} (tonnes)	$PM_{2.5}$ (tonnes)	VOC (tonnes)
Commercial Fuel Combustion	20,638	33,948	7,299	1,447	4,943	4,221	3,641	1,794
Electric Power Generation (Utilities)	621,302	278,874	46,552	1,958	76,212	29,247	12,941	3,936
Residential Fuel Combustion	10,961	36,163	13,735	555	4,570	3,897	3,707	2,322
Residential Fuel Wood Combustion	1,546	10,816	715,354	948	116,127	109,897	109,778	159,346
Total Non Industrial Fuel Combustion Sources	654,447	359,800	782,940	4,908	201,852	147,263	130,066	167,398

*Adapted from the 2002 National CAC Inventory[vii], numbers may not add up due to rounding.

Table 14: 2002 CAC emissions from transportation sources for Alberta and Canada.

A) Alberta*

Category / Sector	SO_2 (tonnes)	NOx (tonnes)	CO (tonnes)	NH_3 (tonnes)	PM_{tot} (tonnes)	PM_{10} (tonnes)	$PM_{2.5}$ (tonnes)	VOC (tonnes)
Air Transportation	451	7,446	6,794	3	243	135	95	1,293
Heavy-Duty Diesel Vehicles	714	55,638	11,462	85	1,526	1,526	1,408	2,165
Heavy-Duty Gasoline Trucks	152	7,408	48,681	55	104	101	83	2,640
Light-Duty Diesel Trucks	83	1,511	1,176	6	172	172	158	638
Light-Duty Diesel Vehicles	4	95	93	0	10	10	9	31
Light-Duty Gasoline Trucks	692	21,927	494,232	973	236	229	179	29,642
Light-Duty Gasoline Vehicles	436	18,365	355,921	899	72	70	65	23,502
Marine Transportation	0	0	0	0	0	0	0	0
Motor Cycles	3	186	2,274	2	3	3	2	340
Off-Road Use Of Diesel	3,211	86,261	47,549	53	9,293	9,293	9,015	9,847
Off-Road Use Of Gasoline	65	12,428	258,492	7	538	538	499	21,251
Rail Transportation	628	14,572	2,602	1	324	324	275	685
Tire Wear & Brake Lining	0	0	0	0	586	579	200	0
Total Transportation Sources	6,437	225,836	1,229,276	2,084	13,108	12,981	11,988	92,035

*Adapted from the 2002 National CAC Inventory[vii], numbers may not add up due to rounding.

B) Canada*

Category / Sector	SO_2 (tonnes)	NOx (tonnes)	CO (tonnes)	NH_3 (tonnes)	PM_{tot} (tonnes)	PM_{10} (tonnes)	$PM_{2.5}$ (tonnes)	VOC (tonnes)
Air Transportation	3,844	63,230	56,323	26	2,092	1,157	816	9,609
Heavy-Duty Diesel Vehicles	5,364	302,054	59,867	492	8,361	8,361	7,722	11,365
Heavy-Duty Gasoline Trucks	647	27,994	161,681	211	407	395	322	9,643
Light-Duty Diesel Trucks	334	4,914	3,817	20	574	574	529	2,056
Light-Duty Diesel Vehicles	95	1,604	1,610	9	172	172	158	496
Light-Duty Gasoline Trucks	5,603	128,331	2,628,095	6,789	1,241	1,204	998	154,638
Light-Duty Gasoline Vehicles	6,181	157,446	2,861,260	10,434	845	821	775	178,284
Marine Transportation	31,135	112,468	9,068	314	5,575	5,575	5,328	7,569
Motor Cycles	23	1,242	15,656	10	21	20	14	3,161
Off-Road Use Of Diesel	15,239	383,180	211,354	235	40,975	40,975	39,746	44,124
Off-Road Use Of Gasoline	901	55,080	2,249,191	82	7,940	7,940	7,317	265,778
Rail Transportation	5,190	120,210	21,510	10	2,680	2,680	2,277	5,660
Tire Wear & Brake Lining	0	0	0	0	4,578	4,526	1,580	0
Total Transportation Sources	74,546	1,357,753	8,279,432	18,634	75,460	74,400	67,583	692,383

*Adapted from the 2002 National CAC Inventory[xii], numbers may not add up due to rounding.

Table 15: 2002 CAC emissions from incineration sources for Alberta and Canada.

A) Alberta*

Category / Sector	SO_2 (tonnes)	NOx (tonnes)	CO (tonnes)	NH_3 (tonnes)	PM_{tot} (tonnes)	PM_{10} (tonnes)	$PM_{2.5}$ (tonnes)	VOC (tonnes)
Crematorium	1	3	1	0	0	0	0	0
Industrial & Commercial Incineration	0	0	0	0	0	0	0	0
Municipal Incineration	0	0	0	0	0	0	0	0
Wood Waste Incineration	0	0	0	0	0	0	0	0
Other Incineration & Utilities	380	3,978	565	596	239	161	158	456
Total Incineration Sources	381	3,981	566	596	239	161	158	456

B) Canada*

Category / Sector	SO_2 (tonnes)	NOx (tonnes)	CO (tonnes)	NH_3 (tonnes)	PM_{tot} (tonnes)	PM_{10} (tonnes)	$PM_{2.5}$ (tonnes)	VOC (tonnes)
Crematorium	5	31	15	0	3	3	3	1
Industrial & Commercial Incineration	371	384	1,318	46	49	31	29	479
Municipal Incineration	497	1,595	5,906	118	1,646	1,488	1,465	1,588
Wood Waste Incineration	0	0	0	0	0	0	0	0
Other Incineration & Utilities	851	5,375	3,824	3,135	693	493	409	1,310
Total Incineration Sources	1,726	7,386	11,063	3,299	2,390	2,016	1,907	3,379

*Adapted from the 2002 National CAC Inventory[vii], numbers may not add up due to rounding.

Table 16: 2002 CAC emissions from miscellaneous sources for Alberta and Canada.

A) Alberta*

Category / Sector	SO_2 (tonnes)	NOx (tonnes)	CO (tonnes)	NH_3 (tonnes)	PM_{tot} (tonnes)	PM_{10} (tonnes)	$PM_{2.5}$ (tonnes)	VOC (tonnes)
Cigarette Smoking	0	0	298	0	63	63	63	1
Dry Cleaning	0	0	0	0	0	0	0	20
Fuel Marketing	8	2	0	0	0	0	0	10,860
General Solvent Use	0	0	0	0	0	0	0	21,554
Marine Cargo Handling Industry	0	0	0	0	0	0	0	0
Meat Cooking	0	0	0	0	870	870	870	0
Pesticides and Fertilizer Application	0	0	0	58,811	2,926	1,434	410	0
Printing	0	0	0	0	0	0	0	2,100
Structural Fires	0	0	1,163	0	581	575	523	564
Surface Coatings	0	0	0	0	0	0	0	6,729
Human	0	0	0	797	0	0	0	0
Total Miscellaneous Sources	8	2	1,461	59,609	4,441	2,942	1,866	41,827

*Adapted from the 2002 National CAC Inventory[vii], numbers may not add up due to rounding.

B) Canada*

Category / Sector	SO_2 (tonnes)	NOx (tonnes)	CO (tonnes)	NH_3 (tonnes)	PM_{tot} (tonnes)	PM_{10} (tonnes)	$PM_{2.5}$ (tonnes)	VOC (tonnes)
Cigarette Smoking	0	0	2,874	4	607	607	607	10
Dry Cleaning	0	2	1	2	0	0	0	285
Fuel Marketing	84	10	6	3	9	9	7	94,361
General Solvent Use	0	0	0	0	0	0	0	248,872
Marine Cargo Handling Industry	0	0	0	0	2,956	1,622	622	1
Meat Cooking	0	0	0	0	8,739	8,739	8,739	0
Pesticides and Fertilizer Application	0	0	0	192,480	11,213	5,494	1,570	0
Printing	0	73	28	24	13	7	6	48,250
Structural Fires	0	0	9,571	0	4,785	4,737	4,307	4,642
Surface Coatings	0	0	0	0	0	0	0	94,157
Human	0	0	0	3,881	0	0	0	0
Total Miscellaneous Sources	84	85	12,478	196,394	28,322	21,215	15,858	490,578

*Adapted from the 2002 National CAC Inventory[vii], numbers may not add up due to rounding.

Table 17: 2002 CAC emissions from open sources for Alberta and Canada.

A) Alberta*

Category / Sector	SO_2 (tonnes)	NOx (tonnes)	CO (tonnes)	NH_3 (tonnes)	PM_{tot} (tonnes)	PM_{10} (tonnes)	$PM_{2.5}$ (tonnes)	VOC (tonnes)
Agriculture (Animals)	0	0	0	77,992	114,281	73,140	11,428	112,166
Agriculture Tilling and Wind Erosion	0	0	0	0	510,939	249,469	6,972	0
Construction Operations	0	0	0	0	1,198,428	359,525	71,895	0
Dust from Paved Roads	0	0	0	0	232,273	44,519	10,646	0
Dust from Unpaved Roads	0	0	0	0	3,435,038	1,043,119	157,600	0
Forest Fires	50	22,468	705,278	1,511	85,641	72,795	59,949	96,724
Landfills Sites	0	30	0	52	505	42	10	305
Mine Tailings	0	0	0	0	895	72	18	0
Prescribed Burning	12	71	990	8	189	189	189	354
Total Open Sources	62	22,569	706,268	79,563	5,578,188	1,842,868	318,707	209,548

*Adapted from the 2002 National CAC Inventory[xii], numbers may not add up due to rounding.

B) Canada*

Category / Sector	SO_2 (tonnes)	NOx (tonnes)	CO (tonnes)	NH_3 (tonnes)	PM_{tot} (tonnes)	PM_{10} (tonnes)	$PM_{2.5}$ (tonnes)	VOC (tonnes)
Agriculture (Animals)	0	0	0	310,051	287,857	184,228	28,786	271,709
Agriculture Tilling and Wind Erosion	0	0	0	0	1,804,018	880,379	24,753	0
Construction Operations	2	0	86	0	2,135,981	640,744	127,938	0
Dust from Paved Roads	0	0	0	0	2,982,302	571,609	136,755	0
Dust from Unpaved Roads	0	0	0	0	7,398,916	2,344,595	349,441	0
Forest Fires	251	102,972	3,249,474	7,393	397,740	337,349	278,319	440,396
Landfills Sites	360	582	3,013	189	4,909	1,022	668	7,889
Mine Tailings	0	0	0	0	32,544	2,604	651	0
Prescribed Burning	150	1,832	68,865	156	11,366	8,406	7,872	6,358
Total Open Sources	763	105,386	3,321,438	317,788	15,055,634	4,970,936	955,183	726,353

*Adapted from the 2002 National CAC Inventory[vii], numbers may not add up due to rounding.

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